

Shaula Bridge as a New Lifeline to Its Both Sided Fluvio-coastal Rural Areas over Purba Medinipur Coast in West Bengal: A Cost-Benefit Analysis, EIA and SWOT Assessment

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Abstract - Medinipur district over Bengal Coast is lengthened about 60 km coastal division and extended from the Kolaghat urbane landscape on the right banks of the Rupnarayan River to Digha tourism townscape in Subarnarekha deltaic region, having about 27% of total coastline of West Bengal, including major coastal towns like Haldia, Khejuri, Junput, Baguran Jalpai, Dadanpatrabar, Contai, Tajpur and so on. Shaula Bridge over Pichhabani estuary under Rasulpur-Pichhabani fluvio-coastal basin is one of the connecting configurations in terms of transport-travel-tourism infrastructure and facilities in between Mandermoni and Junput sectors on Midnapore coast. Under the institutional Marine Drive Project (proposed in 2018) for promoting smart travel-tourism of Bengal coast this bridge has been constructed and opened on June, 2022 showing the huge opportunities to both side's coastal inhabitants as well as tourists. Not only that regional blue economy including fishing, aquaculture and tourism alongwith agriculture and business has been accelerated in remarkable way. Benefits from socio-cultural horizons are also notable in time. Although, this bridge construction draws a lot of benefits, a noteworthy account of both environmental and human costs is not negligible also. Hence, this research paper wants to assess the cost-benefit of Shaula Bridge as the first ever research on it. The study reflects the confused socio-economic shifting of local people in the selection of their future with certain and sustained life earning way for time. Occupational shifting, migration of local youths and sometimes career uncertainty reflect the big question on coastal livelihood. Construction of marine drive along with bridge construction promotes the growth of mass tourism here undoubtedly. But the costs are also vital from the view point of coastal landscape sustainability. Occupying the sensitive fluvio-coastal land features of Pichhabani estuary like tidal drainage, wetland, grasslands, vegetation cover, etc, it has been constructed mostly. Not only has that after its construction mass tourism has been expanding quickly encroaching various fragile habitats and ecosystems on and along this coastal segment. Unfortunately, development is not balanced with proper monitoring and management here. Consequently, coastal vulnerability and risk have been increasing day after day. Under this background this study attempts to assess the cost-benefit and also SWOT of this bridge. Through the intensive observation, extensive surveys and interviews and careful statistical and mapping analysis this paper has been configured for beneficial bridge construction, but with the proper, project, policy, programme and practices for secured life and sustained environment in this potential landscape.

Key words: *Marine Drive, blue economy, cost-benefit, SWOT, secured life and sustained environment.*

I. INTRODUCTION

The coast has always been at the forefront of civilization and is far from the most exploited region of the world. Ease of access and resources have always attracted human activities, but their difficulty in obtaining has led to misuse and abuse. Many factors cause increased stress in coastal areas. These include rapid population growth due to coastal urbanization and industrialization, misuse of coastal areas, and the highest incidence of natural disasters on the coasts. Coastal areas account for only 8% of the world's habitat, but within 100 and 150 km of the coast are 37% and 44% of the world's population,

respectively (based on 1994) (Cohen et al., 1997). The majority of the population growing up in coastal areas in developing countries is the lowest income groups (Sorensen, 2002).

Development is both a material or physical reality and a mental state in which people secure their way to a better life through the integration of social, cultural work and processes (Todaro and Smith, 2006). Infrastructure development plays an important role in economic growth and poverty reduction. Physical infrastructure refers to the physical structures necessary for the operation and survival of businesses, such as transportation, energy plans, sewage systems, and waste treatment (Das, 2017). Transportation among different physical structures plays an important role in improving the livelihoods of rural people. In rural development, roads are designed to improve people's mobility, increase access to workplaces, administrative centres, schools and healthcare facilities, and are believed to lead to significant changes in society.

Improving transport is an important step in economic and social development and often leads to land reform. Human activities continue to shape the landscape, change land use, and disrupt local economies through urban expansion, agriculture, infrastructure, and use of natural resources. In many countries around the world, cities with good transportation infrastructure can support regional development and attract local capital and international investment. The development of transportation can bring economic and social benefits from business and urban development. Coasts and active estuaries, especially bays and lakes, are often economically important; It supports agriculture, fishing, transportation, mining and tourism. However, due to limited land resources, these areas face challenges in protecting fragile ecosystems and promoting economic development at the same time. Land use and land cover (LULC) in these areas is changing rapidly, especially after the completion of large projects such as the construction of bridges over the sea. Bridges play a role in connecting urban agglomerations, boosting urban and rural areas, and promoting business, tourism, and other economic development, but they also impact local ecosystems. Analysis of the nature of bridge construction is important because it can provide insight into the physical, social and economic changes that followed. The impacts of bridge construction on land use and land use are similar to those on public health.

Digha and Mandarmani are two popular seaside tourist destinations over Midnapore coast facing the Bay of Bengal in the South Bengal Basin of India. While Digha, with its old and new tourism sprawl is in its matured state of tourism activity, Dakshin Purushottampur is a fairly new addition in the Digha-Mandermoni tourism map of the State that has grown largely driven by market forces. However, both areas fall within an active coastal belt where shoreline has been reported to be changing with erosion and/or accretion due to littoral transport (i.e. movement of eroded sand by waves in near shore zone). Natural processes like wave currents, near-shore circulation, sediment characteristics, beach forms etc. and human interventions such as dykes and dams, dredging, sand mining, water extraction, tourism etc. are responsible for such unintended changes (ibid).

In fact, after proposing the Marine Drive Project under DSDA by the incentive from respected Chief Minister, Mrs. Mamta Banerjee in 2018, this Marine Drive of 29.5 km from Digha to Shaula, it has been started to construct throughout the region. [16] [17] [18] [19] [20] [21] [22] Although it is incomplete due to under construction status of the bridge over Champa River nearby Digha Mohana, after completion of Jaldha and Shaula bridges and Marine Drive over Sankarpur-Tajpur and Mandermoni-Purushottampur Segment, it has been inaugurated on June, 2022 by the concerned authority and prime character. [16] [17] [18] [19] [20] [21] [22] A remarkable 15.695 km of marine drive with two bridges (13.35 km of marine drive, 1.45 km of Shaula Bridge and 0.895 km of Jaldha Bridge) is not only the well decoration of transport network, but also the stimulating character to regional economic growth now. But, after the constructions of Marine Drive and Shaula and Jaldha Bridges, mass tourism of the study area has been accelerated tremendously. As the result, due to illegal, haphazard and unscientific development of mass tourism in terms of blue economy previously existed traditional fishing and fish farming have been diluting and loosening its dignities in the study area. Hence, a silent conflict between tourism vs. fishing and aquaculture is well observed here which influences the local livelihood and development also.

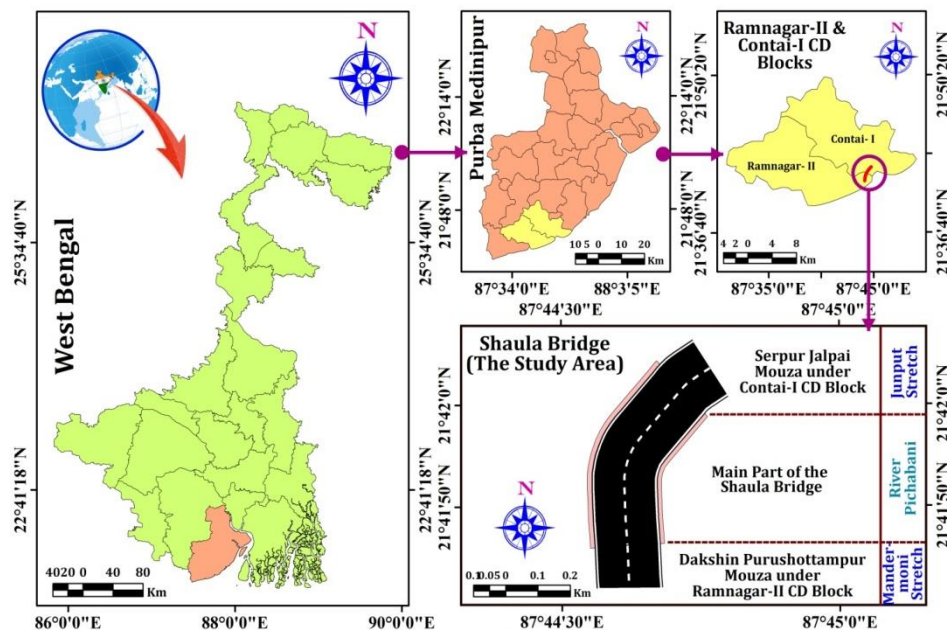
Shaula Bridge is one of three bridges on and along Digha-Soula Marine Drive. Where Marine drive is declaring its closing, this bridge is situated there connecting Dakshin Purushottampur Mouza on Mandermoni coastal sector under Ramnagar – II CD Block and Serpur Jalpai on Junput Coastal Sector under Contai-I CD Block in Purba Medinipur district. This was the long time demand from local background. Naval communication was the only way to reach at the Contai segment till date and meandering costly long route journey was the only way to go to Contai Municipality for drawing the socio-economic and administrative facilities till date (May, 2022). Further, one person must have to take long way to reach at the Mandermoni sector and also Digha segment from Junput coast. Hence, this bridge is very important for not only from the view point of transport and communication, but also for the smoothness of different socio-economic, administrative, recreational and other activities.

The purpose of this research paper is to enlighten not only the advantages of this bridge as the lifeline of two sides regions, but also to assess its cost-benefits on local livelihood and also environment. Coast-Benefit analysis is made to achieve the said purpose.

II. LOCATION OF THE STUDY AREA

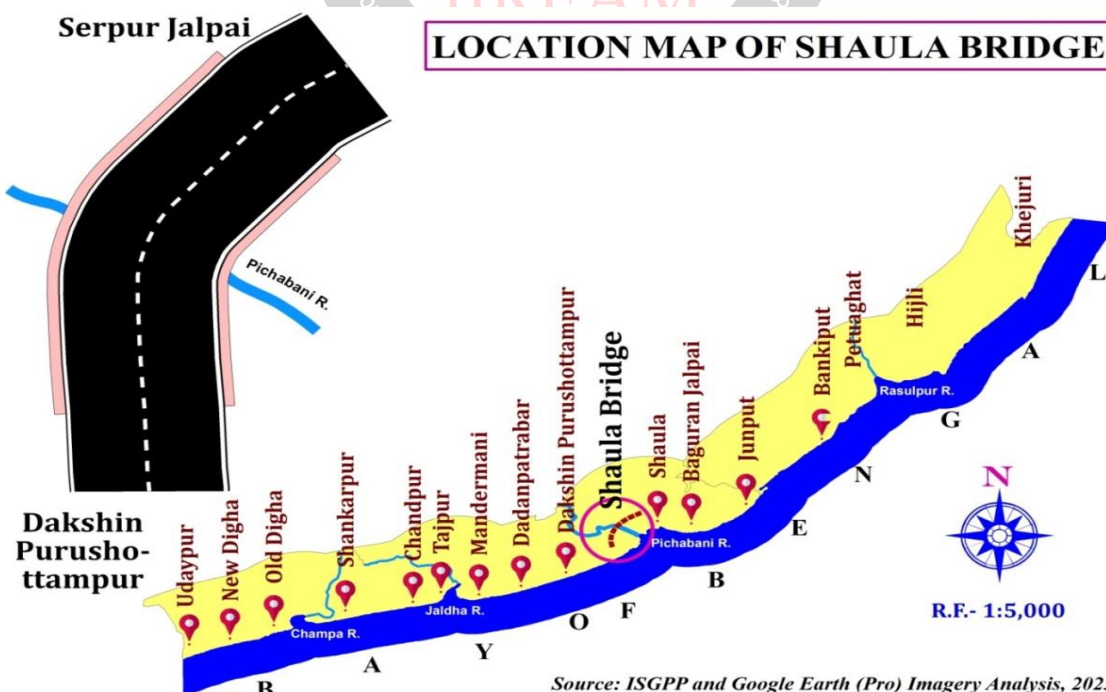
The study area, Shaula Bridge is located in between $21^{\circ}41'42''\text{N}$ – $21^{\circ}41'57''\text{N}$ and $87^{\circ}44'30''\text{E}$ - $87^{\circ}44'47''\text{E}$. Geomorphologically, this bridge is constructed over Pichhaboni river nearby its mouth having the geomorphic characteristics of fluvio-coastal landscape over Midnapore as well as Bengal coast. From the view point of political and administrative background, the bridge connects Dakshin Purushottampur village under Kalindi GP on Mandermani coastal stretch of Ramnagar-II CD Block and Serpur Jalpai village under Nayaput GP on Junput coastal stretch of Contai-I CD Block of Contai Sub-division in Purba Medinipur district of West Bengal. Administratively, it has been brought into under the supervision of Digha-Sankarpur Development Authority (DSDA), the autonomous body of coastal monitoring, development and management on Midnapore coast. Side by side, this area is under the influence of both Contai Coastal Police Station and Mandermoni Coastal Police Station on and along Contai/ Midnapore coastal tourism stretch. The bridge is over Pichhaboni River nearby mouth region and surrounded by Serpur Jalpai at the north, Dakshin Purushottampur at the south, Pichhaboni estuary at and Bay of Bengal at the east and upward Pichhaboni river and its influenced basin at the west respectively.

LOCATION MAP OF THE STUDY AREA



Source: ISGPP, IGISMAP, Thy Maps Guide & Google Earth Imagery- 2023

Map-1: Location of the Study Area, Shaula Bridge connecting Junput and Mandermoni Coastal Stretches



Source: ISGPP and Google Earth (Pro) Imagery Analysis, 2023

Map-2: Village Layout under the Study Area, Mandermoni Coastal Stretch, Purba Medinipur

III. SPECIFIC OBJECTIVES

- ❖ To look into and assess the costs and benefits of Shaula Bridge under marine drive project in the study area;
- ❖ To assess the impacts of this marine drive bridge on coastal livelihood, landscape and environment in the study area;
- ❖ To assess the SWOT of this marine drive bridge in the region;
- ❖ To build up a proper planning outline for its sustainable management in terms of sustained livelihood and environment of the study area in time.



Photoplate 1: Different Outlooks of Shaula Bridge

IV. Materials, Methods and Methodology

4.1 Comprehensive Methods and Methodology for the Study:

Table-1: Stage/ Phase wise Various Methods for the Study/ Research				
Pre-Field Stage	Field Stage	Post Field Stage		
Stage –I: Preparatory Phase (Stage of Preparation)	Stage –II: Collecting Phase (Stage of Collection)	Stage –III: Processing Phase (Stage of Operation): Data Processing, Data Analysis & Interpretation	Stage –IV: Monitoring Phase (Stage of Justification)	Stage –V: Concluding Phase (Recommendation & Conclusion)
<ul style="list-style-type: none"> Study Area Selection Problem Selection and Statement of the Problem Literature Review: Offline Literature Review/ Library Research & Online Literature Review Objectives Formulation Preparation of Data Collection Tools & Techniques Sampling Techniques Fixation Survey Schedule/ Questionnaire Making 	<ul style="list-style-type: none"> Collection of primary data through different kinds of sampling, survey and interview with photo documentation Collection of secondary like data through previous records, books, reports, articles, journals, documents from various sources 	<ul style="list-style-type: none"> Data gathering, compilation & organization Laboratory Analysis of collected samples & data documentation Various Statistical analysis and presentation with proper statistical software Mapping Analysis/ Digital Analysis of Remote Sensing Data: LULC and other relevant mapping analysis with proper GIS software Interpretation / discussion of all above statistical and mapping analysis Selection, editing and organizing the documented photos/ pictures for ground truth verification 	<p>Monitoring the data, result and presentation</p>	<ul style="list-style-type: none"> Making the draft of research paper/ report Making the summary of findings Multi-criteria Decision Making Making the recommendations for action Making the planning strategies & preparing the planning blueprint and Finalization of Research Report/ Paper

Source: Author's Own Composition, 2023

4.2 Major database, software and sampling techniques used for the study:

Table-2: Major database, software and sampling techniques used for project			
Major Database	Major Software	Major Survey Techniques	Major Sample Techniques
<ul style="list-style-type: none"> Satellite Images like <ul style="list-style-type: none"> LANDSAT-Series IRS Series, etc. 	<ul style="list-style-type: none"> ARC GIS GPS MS Excel 	<ul style="list-style-type: none"> Literature Survey Traversing & GPS Tracking Perception Survey on Target 	<ul style="list-style-type: none"> Systematic Random Sampling

<ul style="list-style-type: none"> Different Base Maps collected from various institutions/ organization/ departments ISGPP, IGISMAP and Google Earth Imagery-2023 Bhuvan: Indian Geo-platform of ISRO Database of Different Govt./ Administrative Offices/ Departments Census Records/ Documents Institutional/ Departmental/ Organizational Draft Report/ Audit Report/ Progress Report, etc. 	<ul style="list-style-type: none"> SPSS IBM 	<ul style="list-style-type: none"> Group (Structured Questionnaire Method) ❖ Institutional Survey (Structured Questionnaire Method) ❖ Individual Interview (Formal Method) 	<ul style="list-style-type: none"> ❖ Stratified Random Sampling ❖ Stratified Random Sampling ❖ Purposive Sampling, etc.
Source: Author's Own Composition, 2023			

4.3 Nature and Categories of the Respondents for the Study:

For this study, I have selected 202 respondents from both side villages including households and other related characters (table-2.6 and figure-2.2) for their valuable responses or perceptions. The data table-3 and figure-1 reflect that among the respondents, 17.43% belongs to late young to early mature including common people (victims), leaders and representatives in the study area whereas 38.98% of them is elderly and senior citizens including older and experienced common people, academicians, environmentalists and experienced persons. About 43.6% of the respondents under mature to early older category includes experienced common people (victims), academicians, environmentalists and officials, leaders and representatives. This respondent profile shows the enhancement on older, experienced and expert characters for such an important perception survey.

Table-3: Category wise respondents from both sided villages of Shaula Bridge

Name of Villages	Categories of Respondents	Number of Respondents	% of Respondents w.r.t. Village	% of Respondents w.r.t. Total
Dakshing Purushottampur (Southern Side)	Household Respondents	51	41.80	60.40
	Employees from fishing, aquaculture, business, agriculture, etc.	23	18.85	
	Tourism related respondents	36	29.51	
	others	12	9.84	
Serpur Jalpai (Northern Side)	Household Respondents	35	43.75	39.60
	Employees from fishing, aquaculture, business, agriculture, etc.	26	32.5	
	Tourism related respondents	10	12.5	
	others	9	11.25	
Total		202		100

Source: Field Survey, 2023

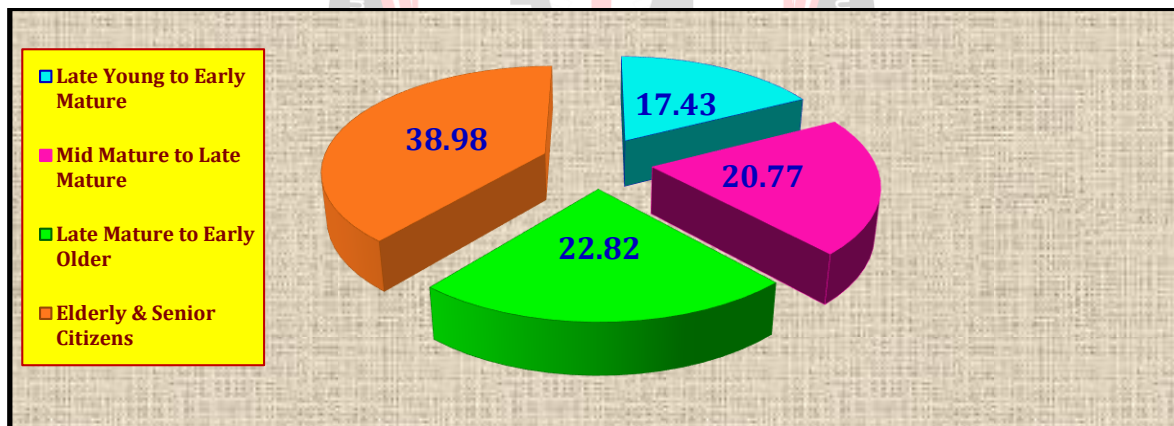


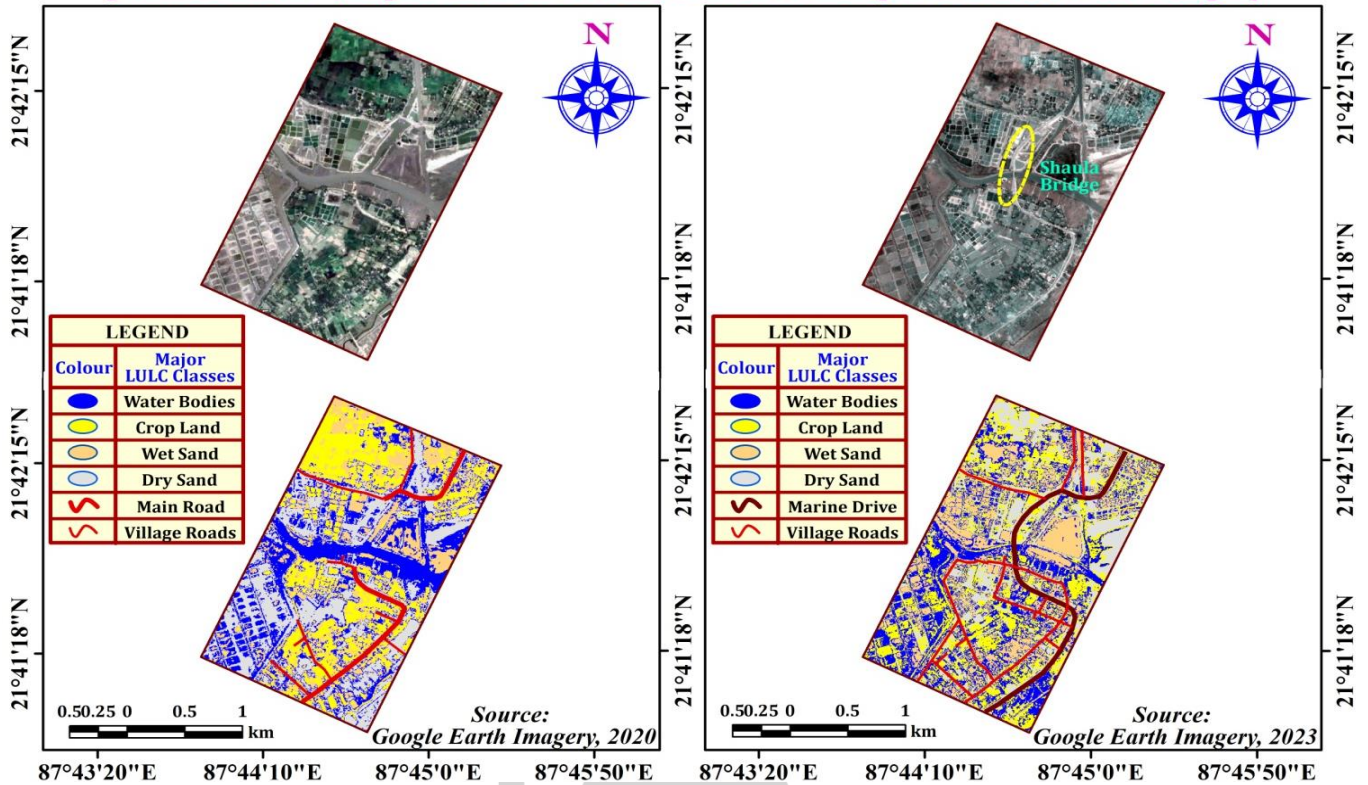
Figure-1: Age Categories of the Sample Respondents for Perception Survey

V. Influence of Bridge cum Marine Drive Construction on the Adjacent Study Area:

5.1 Comprehensive LULC of the Bridge and Adjacent Areas:

Although the Bridge is constructed over Pichhabani River nearby its mouth meeting to Bay of Bengal, a lot of lands have been required to configure it and its approach road. Both sided aquacultural and riverine wetlands have been taken for its construction mainly. A few amounts of agricultural lands have been accepted also. Grazing lands and waste lands are taken for its construction. Hence, it is clear that several sensitive coastal land covers and also features have been destroyed and degraded to construct and configure this bridge of vital transport-communication connectivity for the region. So, LULC scenario reflects a lot of change under and adjacent areas of the bridge.

[Mandermoni - Junput Coastal Stretch, Purba Medinipur District, West Bengal]



Map-3: Spatio-temporal Changes in LULC along and adjacent areas of Shaula Bridge before and after its construction

5.2 Perception on Feelings and Satisfaction on Bridge Construction along the Marine Drive:

Table-4: Perception on Feelings and Satisfaction on Bridge Construction along the Marine Drive

Sl. No.	Facts regarding Bridge and Marine Drive	Number of Responses			% of Responses		
		Yes	No	Total	Yes	No	Total
1.	Are you pleased on the construction of Bridge and Marine Drive throughout the region?	129	31	160	80.63	19.38	100
2.	Are you satisfied on the construction of Bridge and Marine Drive in the region?	96	64	160	60.00	40.00	100
3.	Are you pleased on the growing mass tourism for Bridge Construction in the region?	81	79	160	50.63	49.38	100
4.	Are you satisfied on the growing mass tourism for Bridge Construction throughout the region?	79	81	160	49.38	50.63	100
5.	Do you feel the comfort on increasing interference of outsiders or external affairs throughout the region in terms of bridge construction and mass tourism development?	57	103	160	35.63	64.38	100
6.	Have you changed your occupation after developing the bridge, marine drive and also mass tourism in the region?	59	101	160	36.88	63.13	100
7.	Have your standard of living been upgraded/ degraded after developing the bridge, marine drive and also mass tourism in the region?	69	91	160	43.13	56.88	100
8.	Are you pleased and satisfied in the roles of local administration for developing the bridge, marine drive and also mass tourism in the region?	77	83	160	48.13	51.88	100
9.	Are you pleased and satisfied in the roles of local representative/ leaders for developing the bridge, marine drive and also mass tourism in the region?	72	88	160	45.00	55.00	100
10.	Are you pleased and satisfied in the roles of govt. or institution for developing the bridge, marine drive and also mass tourism in the region?	59	101	160	36.88	63.13	100
11.	Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional livelihood?	77	83	160	48.13	51.88	100
12.	Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional development?	76	84	160	47.50	52.50	100
13.	Do you feel this development of bridge, marine drive and mass tourism are declining/ degrading the local resources?	96	64	160	60.00	40.00	100
14.	Do you feel this development of bridge, marine drive and mass tourism can deprive/ degrade the local environment and its sustainability?	93	67	160	58.13	41.88	100
15.	Do you feel this development of bridge, marine drive and mass tourism can secure your next generation for their safe livelihood?	73	87	160	45.63	54.38	100
Total		N = 160			N (%) = 100		

Source: Field Survey, March-June, 2023

The table 4 shows the various perceptions of local household people, shop keepers, tourists, different job holders and others on the bridge construction and marine drive and developing mass tourism in the study area. The respondents have given their opinion as well as feelings and satisfactions regarding marine drive and mass tourism. In most of the cases respondents are for marine drive and tourism development in the study area, but not degrading the local environment and also other economies which are existed habitually in this area. On an average scale respondents are traditionally or moderately satisfied on the roles and responsibilities of local political parties, representatives, administration and also government in case of marine drive and tourism development.

Table-5: Perception on Magnitude of Feelings and Level of Satisfaction on Marine Drive and Mass Tourism in the Study Area

Facts	Number of the Responses							% of the Responses						
	VH	H	M	L	VL	No	T	VH	H	M	L	VL	No	T
Are you pleased on the construction of Bridge cum Marine Drive throughout the region?	28	39	38	19	5	31	160	17.50	24.38	23.75	11.88	3.13	19.38	100.00
Are you satisfied on the construction of Bridge cum Marine Drive in the region?	19	27	36	11	3	64	160	11.88	16.88	22.50	6.88	1.88	40.00	100.00
Are you pleased on the growing mass tourism for Bridge Construction in the region?	13	21	23	17	7	79	160	8.13	13.13	14.38	10.63	4.38	49.38	100.00
Are you satisfied on the growing mass tourism for Bridge Construction throughout the region?	8	21	17	25	8	81	160	5.00	13.13	10.63	15.63	5.00	50.63	100.00
Do you feel the comfort on increasing interference of outsiders or external affairs throughout the region in terms of bridge construction and mass tourism development?	6	13	21	11	6	103	160	3.75	8.13	13.13	6.88	3.75	64.38	100.00
Have you changed your occupation after developing the bridge, marine drive and also mass tourism in the region?	10	13	18	11	7	101	160	6.25	8.13	11.25	6.88	4.38	63.13	100.00
Have your standard of living been upgraded/ degraded after developing the bridge, marine drive and also mass tourism in the region?	12	16	21	13	7	91	160	7.50	10.00	13.13	8.13	4.38	56.88	100.00
Are you pleased and satisfied in the roles of local administration for developing the bridge, marine drive and also mass tourism in the region?	7	19	26	11	14	83	160	4.38	11.88	16.25	6.88	8.75	51.88	100.00
Are you pleased and satisfied in the roles of local representative/ leaders for developing the bridge, marine drive and also mass tourism in the region?	9	15	20	15	13	88	160	5.63	9.38	12.50	9.38	8.13	55.00	100.00
Are you pleased and satisfied in the roles of govt. or institution for developing the bridge, marine drive and also mass tourism in the region?	8	13	17	11	10	101	160	5.00	8.13	10.63	6.88	6.25	63.13	100.00
Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional livelihood?	10	19	22	18	8	83	160	6.25	11.88	13.75	11.25	5.00	51.88	100.00
Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional development?	11	17	25	15	8	84	160	6.88	10.63	15.63	9.38	5.00	52.50	100.00
Do you feel this development of bridge, marine drive and mass tourism are declining/ degrading the local resources?	22	31	22	12	9	64	160	13.75	19.38	13.75	7.50	5.63	40.00	100.00
Do you feel this development of bridge, marine drive and mass tourism can deprive/	14	38	20	13	8	67	160	8.75	23.75	12.50	8.13	5.00	41.88	100.00

degrade the local environment and its sustainability?														
Do you feel this development of bridge, marine drive and mass tourism can secure your next generation for their safe livelihood?	10	23	17	10	13	87	160	6.25	14.38	10.63	6.25	8.13	54.38	100.00
	N = 160							N (%) = 100						
Source: Field Survey, March-June, 2023														

To assess the magnitude of perception on marine drive and bridge construction and also tourism development, the following questions are given to the respondents of different fields:

- ❖ Are you pleased on the construction of Bridge and Marine Drive throughout the region?
- ❖ Are you satisfied on the construction of Bridge and Marine Drive in the region?
- ❖ Are you pleased on the growing mass tourism for Bridge Construction in the region?
- ❖ Are you satisfied on the growing mass tourism for Bridge Construction throughout the region?
- ❖ Do you feel the comfort on increasing interference of outsiders or external affairs throughout the region in terms of bridge construction and mass tourism development?
- ❖ Have you changed your occupation after developing the bridge, marine drive and also mass tourism in the region?
- ❖ Have your standard of living been upgraded/ degraded after developing the bridge, marine drive and also mass tourism in the region?
- ❖ Are you pleased and satisfied in the roles of local administration for developing the bridge, marine drive and also mass tourism in the region?
- ❖ Are you pleased and satisfied in the roles of local representative/ leaders for developing the bridge, marine drive and also mass tourism in the region?
- ❖ Are you pleased and satisfied in the roles of govt. or institution for developing the bridge, marine drive and also mass tourism in the region?
- ❖ Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional livelihood?
- ❖ Do you feel this development of bridge, marine drive and mass tourism can progress and promote the regional development?
- ❖ Do you feel this development of bridge, marine drive and mass tourism are declining/ degrading the local resources?
- ❖ Do you feel this development of bridge, marine drive and mass tourism can deprive/ degrade the local environment and its sustainability?
- ❖ Do you feel this development of bridge, marine drive and mass tourism can secure your next generation for their safe livelihood?

The respondents are requested to expose their feelings and also satisfaction level on marine drive construction and tourism development. The magnitude of most of the responses on different perceptual dimensions regarding marine drive and tourism is at low, very low and no scale whereas the magnitude at very high, high and moderate scales is comparatively low. This is interesting that most of the people are for both marine drive and tourism development. But they are not satisfied on the ways and techniques for such type development which can degrade their livelihood and environment.

5.3 Livelihood before and after the Construction of Bridge and Marine Drive in the Study Area:

Table-6: Perception on the Livelihood before and after the Construction of Bridge and Marine Drive

Facts before & after the Construction of Bridge cum Marine Drive and Development of Mass Tourism	Perception on Post Fact comparing to Pre-fact (Number)				Perception on Post Fact comparing to Pre-fact (%)			
	Yes		No Change	Total	Yes		No	Total
	Good/ Better	Bad/ Worse			Good/ Better	Bad/ Worse		
Position of household (same/ change)	74	48	38	160	46.25	30.00	23.75	100
Occupation	55	71	34	160	34.38	44.38	21.25	100
Job Opportunity	43	78	39	160	26.88	48.75	24.38	100
Family Income	42	78	40	160	26.25	48.75	25.00	100
Property/ Resource	52	72	36	160	32.50	45.00	22.50	100
Standard of Living	61	66	33	160	38.13	41.25	20.63	100
Livelihood Security & Safety	39	73	48	160	24.38	45.63	30.00	100
Administrative Activation for Development and Management	66	61	33	160	41.25	38.13	20.63	100
Leader's/ Representative's Role in Development and Management	45	63	52	160	28.13	39.38	32.50	100
Local/ Indigenous Resources	50	79	31	160	31.25	49.38	19.38	100
Environmental Loss/ Gain	44	98	18	160	27.50	61.25	11.25	100
Value of Land	136	22	2	160	85.00	13.75	1.25	100
Change in LULC	45	108	7	160	28.13	67.50	4.38	100
Economic Transformation and Growth of the Region	58	83	19	160	36.25	51.88	11.88	100
Livelihood Change in the Region (Positive/ Negative or Better/ Looser)	62	78	20	160	38.75	48.75	12.50	100
Social Development (Health, education, etc.)	49	81	30	160	30.63	50.63	18.75	100

Cultural Development	48	86	26	160	30.00	53.75	16.25	100
Infrastructural Development (Transport & communication, sanitation, electricity, drinking water, drainage, embankment, etc.)	69	65	26	160	43.13	40.63	16.25	100
Average	58	73	30	160	46.25	30.00	23.75	100

Source: Field Survey, March-June, 2023

Different livelihood facts before and after the construction of bridge and marine drive and also development of mass tourism are position of household (same/ change), occupation, job opportunity, family income, property/ resource, standard of living, livelihood security and safety, administrative activation for development and management, leader's/ representative's role in development and management, local/ indigenous resources, environmental loss/ gain, value of land, change in lule, economic transformation and growth of the region, livelihood change in the region (positive/ negative or better/ looser), social development (health, education, etc.), cultural development, etc. on an average, 46.25% of the respondents says their livelihood has been better than before and 30% opines their living ways and status have been degraded than before whereas 23.75% remarks, there is no remarkable change in their livelihood due to marine drive and tourism development here.

5.4 Impacts of Construction of Bridge and Marine Drive on Household in the Study Area:

Table-7: Magnitude of Impacts of Construction of Bridge and Marine Drive on Household

Name of Major Family Impacts	Perception on Status/ Level (Number)				Perception on Status/ Level (%)			
	Increasing/ Upgrading	Decreasing/ Degrading	No Change	Total	Increasing/ Upgrading	Decreasing/ Degrading	No Change	Total
Housing	34	13	39	86	39.53	15.12	45.35	100
Household Infrastructure	31	11	44	86	36.05	12.79	51.16	100
Valuable Goods & Wealth	29	22	35	86	33.72	25.58	40.70	100
Agriculture/ Aquaculture/ Fishing/ Business/ Manufacturing/ others	29	34	23	86	33.72	39.53	26.74	100
Health Status	33	16	37	86	38.37	18.60	43.02	100
Education Status	34	16	36	86	39.53	18.60	41.86	100
Economic Status (Income/ Savings)	33	24	29	86	38.37	27.91	33.72	100
Mental/ Psychological Comfort	21	32	33	86	24.42	37.21	38.37	100
Safety and Security	25	36	25	86	29.07	41.86	29.07	100
Life Style	39	19	28	86	45.35	22.09	32.56	100
Standard of Living	32	18	36	86	37.21	20.93	41.86	100
Average	31	22	33	86	35.94	25.47	38.58	100

Source: Field Survey, March-June, 2023

Table-8: Magnitude of Impacts of Construction of Bridge and Marine Drive on Household

Name of Major Family Impacts	Perception on Magnitude (Number)							Perception on Magnitude (%)						
	VH	H	M	L	Decrease	No	T	VH	H	M	L	Decrease	No	T
Housing	8	11	10	5	13	39	86	9.30	12.79	11.63	5.81	15.12	45.35	100
Household Infrastructure	10	11	7	3	11	44	86	11.63	12.79	8.14	3.49	12.79	51.16	100
Valuable Goods & Wealth	6	10	11	2	22	35	86	6.98	11.63	12.79	2.33	25.58	40.70	100
Agriculture Aquaculture/ Fishing/ Business/ Manufacturing/ others	5	11	11	2	34	23	86	5.81	12.79	12.79	2.33	39.53	26.74	100
Health Status	4	10	13	6	16	37	86	4.65	11.63	15.12	6.98	18.60	43.02	100
Education Status	7	11	12	4	16	36	86	8.14	12.79	13.95	4.65	18.60	41.86	100
Economic Status (Income/ Savings)	8	9	12	4	24	29	86	9.30	10.47	13.95	4.65	27.91	33.72	100
Mental Comfort	5	6	7	3	32	33	86	5.81	6.98	8.14	3.49	37.21	38.37	100
Psychological Comfort	6	8	8	3	36	25	86	6.98	9.30	9.30	3.49	41.86	29.07	100
Safety and Security	6	13	12	8	19	28	86	6.98	15.12	13.95	9.30	22.09	32.56	100
Life Style	7	12	8	5	18	36	86	8.14	13.95	9.30	5.81	20.93	41.86	100
Standard of Living	8	11	10	5	13	39	86	9.30	12.79	11.63	5.81	15.12	45.35	100
Average	7	10	10	4	21	34	86	7.75	11.92	11.72	4.85	24.61	39.15	100

Source: Field Survey, March-June, 2023

The perception based field survey on the impacts of construction of bridge and marine drive on local livelihood in terms of household is also done throughout the study area. The data table 8 reflects the magnitude of impacts of this project on household here. Marine drive impacts on about all aspects of the livelihood including Housing, household infrastructure, valuable goods and wealth, agriculture, aquaculture, fishing, business, manufacturing and likely, health status, education status, economic status (income/ savings), mental comfort, psychological comfort, safety and security, life style, standard of living, etc. have been shown here. Different dimensions have been improved than past. But previously dominated economic

activities have been diluted due to the newly emergence of tourism economy here. Socio-economic complexity has been increased in time. Mental and psychological comforts have been disturbed more or less due to uncertainty in life earning ways relating several economies rather than tourism.

VI. Major Environmental and Socio-economic Costs of the Construction of Bridge cum Marine Drive in the study area:

6.1 Major Environmental Costs of the Construction of Bridge cum Marine Drive:

Table-9: Major Environmental Costs of the Construction of Bridge cum Marine Drive in the study area														
Name of Physical Environmental Costs	Magnitude of the responses/ perceptions on the physical environmental costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Deforestation & Devegetation	47	49	28	18	11	7	160	29.38	30.63	17.50	11.25	6.88	4.38	100
Wetland filling up & Destruction	44	50	29	17	12	8	160	27.50	31.25	18.13	10.63	7.50	5.00	100
Dune Erosion, Mining & Destruction	47	48	30	16	12	7	160	29.38	30.00	18.75	10.00	7.50	4.38	100
Natural Habitat & Ecosystem Loss	40	44	31	20	14	11	160	25.00	27.50	19.38	12.50	8.75	6.88	100
Massive Decline in Coastal Biodiversity	39	45	32	21	13	10	160	24.38	28.13	20.00	13.13	8.13	6.25	100
Rapid Decrease in Coastal Resources	33	45	34	22	14	12	160	20.63	28.13	21.25	13.75	8.75	7.50	100
Quick Decline in Typical Coastal Features	27	43	36	26	17	11	160	16.88	26.88	22.50	16.25	10.63	6.88	100
Increase in Coastal Pollution & Degradation	31	46	31	24	16	12	160	19.38	28.75	19.38	15.00	10.00	7.50	100
Increase in Exposure, Vulnerability & Risk of Coastal Hazards	44	53	26	17	12	8	160	27.50	33.13	16.25	10.63	7.50	5.00	100
Average	39	47	31	20	13	10	160	24.45	29.38	19.24	12.81	8.52	5.97	100

Source: Field Survey, March-June, 2023

6.2 Major Residential Costs of the Construction of Bridge cum Marine Drive:

Table-10: Major Residential Costs of the Construction of Bridge and Marine Drive in the study area														
Name of Residential Costs	Magnitude of the responses/ perceptions on the residential costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Settlement-Tourism-Environment Conflict	31	37	34	28	18	12	160	19.38	23.13	21.25	17.50	11.25	7.50	100
Population Pressure on CRZ violating Its Rule/ Policy	30	36	32	29	21	12	160	18.75	22.50	20.00	18.13	13.13	7.50	100
Constantly increase in immigration through outsider's dominancy	31	41	30	28	18	12	160	19.38	25.63	18.75	17.50	11.25	7.50	100
Haphazard, illegal & unscientific domestic infrastructure	21	22	27	36	33	21	160	13.13	13.75	16.88	22.50	20.63	13.13	100
Average	2.25	34	31	30	23	14	160	17.66	21.25	19.22	18.91	14.07	8.91	100

Source: Field Survey, March-June, 2023

6.3 Major Economic Costs of the Construction of Bridge cum Marine Drive:

Table-11: Major Economic Costs of the Construction of Bridge and Marine Drive in the study area														
Name of Economic Costs	Magnitude of the responses/ perceptions on the economic costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Loosening the base economies of coastal region	22	44	32	27	22	13	160	13.75	27.50	20.00	16.88	13.75	8.13	100
Overuse, abuse & misuse of coastal resources	28	38	32	26	22	14	160	17.50	23.75	20.00	16.25	13.75	8.75	100
Occupational Conflict as Tourism vs. Other Economy	29	37	31	28	20	15	160	18.13	23.13	19.38	17.50	12.50	9.38	100
Rapid development of tourism infrastructure destroying the physical features	32	43	35	23	17	10	160	20.00	26.88	21.88	14.38	10.63	6.25	100
Occupational piracy & Crisis	24	39	36	26	22	13	160	15.00	24.38	22.50	16.25	13.75	8.13	100
Huge price rising & crisis to marginal and poor sector	37	44	27	23	15	14	160	23.13	27.50	16.88	14.38	9.38	8.75	100
New trend towards tourism cum coastal rurbanization rapidly transforming the natural landscape	27	39	33	28	20	13	160	16.88	24.38	20.63	17.50	12.50	8.13	100
Economic dominancy of outsiders & depriving the local community	33	44	33	23	16	11	160	20.63	27.50	20.63	14.38	10.00	6.88	100
Trend to emigration of coastal youths due to lacking the job at home place	24	38	30	27	29	12	160	15.00	23.75	18.75	16.88	18.13	7.50	100
Average	28	41	32	26	20	13	160	18.13	25.42	20.07	16.04	12.71	8.05	100

Source: Field Survey, March-June, 2023

6.4 Major Socio-cultural Costs of the Construction of Bridge cum Marine Drive:

Table-12: Major Socio-cultural Costs of the Marine Drive and Bridge Construction in the study area

Name of Socio-cultural Costs	Magnitude of the responses/ perceptions on the socio-cultural costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Loosening the dignity of coastal culture	24	42	35	26	20	13	160	15.00	26.25	21.88	16.25	12.50	8.13	100
Socio-cultural degradation in terms of tourism culture	26	35	33	29	23	14	160	16.25	21.88	20.63	18.13	14.38	8.75	100
Counter effects of modernism degrading the quality life	29	38	29	31	20	13	160	18.13	23.75	18.13	19.38	12.50	8.13	100
Uninterest of the generation in education	22	36	39	30	19	14	160	13.75	22.50	24.38	18.75	11.88	8.75	100
Traditional socio-cultural development from infrastructure and facilities	20	39	30	38	20	13	160	12.50	24.38	18.75	23.75	12.50	8.13	100
Increase in anti-social and illegal activities throughout the region	26	40	32	26	22	14	160	16.25	25.00	20.00	16.25	13.75	8.75	100
Increasing socio-cultural complexity and segregation	16	33	31	22	29	29	160	10.00	20.63	19.38	13.75	18.13	18.13	100
Addition of youths and active population towards alcoholism, smoking, smuggling, cheating, frauding, thefting, etc.	41	44	32	18	11	14	160	25.63	27.50	20.00	11.25	6.88	8.75	100
Others	16	33	37	30	24	20	160	10.00	20.63	23.13	18.75	15.00	12.50	100
Average	24	38	33	28	21	16	160	15.28	23.61	20.70	17.36	13.06	10.00	100

Source: Field Survey, March-June, 2023

6.5 Major Land Use Land Cover and Landscape oriented Costs of the Construction of Bridge cum Marine Drive:

Table-13: Major LULC & Landscape Oriented Costs of the Marine Drive and Bridge Construction in the study area

Name of LULC and landscape oriented Costs	Magnitude of the responses/ perceptions on the LULC and landscape oriented costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Rapid transformation of land covers in land uses	33	38	30	22	20	17	160	20.63	23.75	18.75	13.75	12.50	10.63	100
Quick and limitless valuation of lands & dominance of the promoters & middlemen	32	43	35	24	16	10	160	20.00	26.88	21.88	15.00	10.00	6.25	100
Massive LULC changes violating the land conversion and reform policy	35	43	30	20	20	12	160	21.88	26.88	18.75	12.50	12.50	7.50	100
Illegal, haphazard & unscientific encroachment and utilization of CRZ violating its policy	32	41	33	24	17	13	160	20.00	25.63	20.63	15.00	10.63	8.13	100
Haphazard & unscientific development of tourism capturing and interrupting the most sensitive coastal features and processes	31	38	30	28	19	14	160	19.38	23.75	18.75	17.50	11.88	8.75	100
Enormous loss and degradation of coastal habitats and ecosystem in terms of coastal ecology	31	40	31	24	20	14	160	19.38	25.00	19.38	15.00	12.50	8.75	100
Acute destruction of sea walls/ guards intensifying the tourismcape	35	42	32	24	13	14	160	21.88	26.25	20.00	15.00	8.13	8.75	100
Destroying the stability and mining the potentiality of coastal landscape	28	43	30	24	16	19	160	17.50	26.88	18.75	15.00	10.00	11.88	100
Average	32	41	31	24	18	14	160	20.08	25.63	19.61	14.84	11.02	8.83	100

Source: Field Survey, March-June, 2023

Table-14: Other Costs of the Marine Drive and Bridge Construction in the study area

Name of Costs	Magnitude of the responses/ perceptions on the other costs													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Plan-Policy-Programme Gaps & Poor Management	24	37	32	28	23	16	160	15.00	23.13	20.00	17.50	14.38	10.00	100
Public-Politics-Policy Maker-Prime Character-Practitioner Conflicts & Gaps and Poor Management	26	34	37	28	19	16	160	16.25	21.25	23.13	17.50	11.88	10.00	100
Community Ignorance in development and management	21	38	30	32	22	17	160	13.13	23.75	18.75	20.00	13.75	10.63	100

Institutional Policy ignorance and violation and regional environmental degradation	25	39	34	28	18	16	160	15.63	24.38	21.25	17.50	11.25	10.00	100
Unscientific plan & policy promoting the illegal development of the region	24	33	37	28	20	18	160	15.00	20.63	23.13	17.50	12.50	11.25	100
Average	24	36	34	29	20	17	160	15.00	22.63	21.25	18.00	12.75	10.38	100

Source: Field Survey, March-June, 2023

Table 9, 10, 11, 12, 13 and 14 along with corresponding figures show different physical environmental and socio-economic costs of the construction of bridge and marine drive in the study area. Excluding tourists, other types of respondents have given their perceptions in this case. Data shows that all the costs have been highly and moderately emphasized rather than its low magnitude. Hence, it is clear that a lot of environmental and human costs have been resulted from the construction of bridge and marine drive throughout the study area.

VII. Major Environmental and Socio-economic Benefits of the Bridge cum Marine Drive Construction in the Study Area:

7.1 Major Environmental Benefits of the Bridge cum Marine Drive Construction:

Table-15: Major Environmental Benefits on the study area due to Marine Drive and Bridge Construction														
Name of Environmental Benefits	Magnitude of the responses/ perceptions on the environmental benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Proper utilization of natural scenic beauty	36	37	35	28	12	12	160	22.50	23.13	21.88	17.50	7.50	7.50	100
Proper utilization of coastal unused lands	21	34	42	28	22	13	160	13.13	21.25	26.25	17.50	13.75	8.13	100
Emphasizing natural resources through tourism and development	22	34	38	26	27	13	160	13.75	21.25	23.75	16.25	16.88	8.13	100
Management of Vulnerability and Risk of Coastal Hazards through tourism development	13	36	37	30	28	16	160	8.13	22.50	23.13	18.75	17.50	10.00	100
Average	23	35	38	28	22	14	160	14.38	22.03	23.75	17.50	13.91	8.44	100

Source: Field Survey, March-June, 2023

7.2 Major Environmental Benefits of the Bridge cum Marine Drive Construction:

Table-16: Major Residential Benefits on the study area due to Marine Drive and Bridge Construction														
Name of Residential Benefits	Magnitude of the responses/ perceptions on the residential benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Residential and infrastructural development of coastal community through tourism	27	34	32	34	19	14	160	16.88	21.25	20.00	21.25	11.88	8.75	100
Mitigating the inland population pressure absorbing the immigration here	16	33	36	34	24	17	160	10.00	20.63	22.50	21.25	15.00	10.63	100
Average	22	34	34	34	22	16	160	13.44	20.94	21.25	21.25	13.44	9.69	100

Source: Field Survey, March-June, 2023

7.3 Major Economic Benefits of the Bridge cum Marine Drive Construction:

Table-17: Major Economic Benefits on the study area due to Marine Drive & Bridge Construction														
Name of Economic Benefits	Magnitude of the responses/ perceptions on the economic benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Socio-economic infrastructural development	31	35	37	26	19	12	160	19.38	21.88	23.13	16.25	11.88	7.50	100
Proper use of coastal resources	19	32	39	26	27	17	160	11.88	20.00	24.38	16.25	16.88	10.63	100
Occupational opportunity through tourism	21	29	30	31	28	21	160	13.13	18.13	18.75	19.38	17.50	13.13	100
Specific development of coastal transport corridor	38	40	34	18	16	14	160	23.75	25.00	21.25	11.25	10.00	8.75	100
Tourism as the proper alternative to traditional coastal economy	19	28	36	31	29	17	160	11.88	17.50	22.50	19.38	18.13	10.63	100
Homeplace income opportunity controlling emigration	25	32	31	30	26	16	160	15.63	20.00	19.38	18.75	16.25	10.00	100
Tourism cum coastal urbanization as the better way to livelihood development	22	32	34	30	22	20	160	13.75	20.00	21.25	18.75	13.75	12.50	100

Tourism as better one comparing to other blue economies	21	32	30	34	26	17	160	13.13	20.00	18.75	21.25	16.25	10.63	100
Development of local as well as regional economy providing higher GDP	20	27	30	28	28	27	160	12.50	16.88	18.75	17.50	17.50	16.88	100
Average	24	32	33	28	25	18	160	15.00	19.93	20.90	17.64	15.35	11.18	100

Source: Field Survey, March-June, 2023

7.4 Major Socio-cultural Benefits of the Bridge cum Marine Drive Construction:

Table-18: Major Socio-cultural Benefits on the study area due to Marine Drive & Bridge Construction														
Name of Socio-cultural Benefits	Magnitude of the responses/ perceptions on the socio-cultural benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Scope and opportunity to the development of socio-cultural infrastructure & facilities	18	31	37	34	21	19	160	11.25	19.38	23.13	21.25	13.13	11.88	100
Socio-cultural upgradation in contact with tourism culture	26	39	32	23	23	17	160	16.25	24.38	20.00	14.38	14.38	10.63	100
Cultural convergence promoting the quality life	22	37	35	30	18	18	160	13.75	23.13	21.88	18.75	11.25	11.25	100
Increasing the socio-cultural demands towards better lifestyle	23	34	36	29	19	19	160	14.38	21.25	22.50	18.13	11.88	11.88	100
Bringing into the limelight of special development and management	20	34	32	33	24	17	160	12.50	21.25	20.00	20.63	15.00	10.63	100
Others	23	29	32	32	28	16	160	14.38	18.13	20.00	20.00	17.50	10.00	100
Average	22	34	34	30	22	18	160	13.75	21.25	21.25	18.86	13.86	11.05	100

Source: Field Survey, March-June, 2023

7.5 Major LULC and Landscape oriented Benefits of the Bridge cum Marine Drive Construction:

Table-19: Major LULC and Landscape Oriented Benefits on the study area due to Marine Drive and Bridge Construction														
Name of LULC and Landscape oriented Benefits	Magnitude of the responses/ perceptions on the LULC and Landscape oriented benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Better land use of non-productive and unfertile lands	25	33	34	31	20	17	160	15.63	20.63	21.25	19.38	12.50	10.63	100
Proper transformation of coastal landscape into effective economy	20	35	38	28	24	15	160	12.50	21.88	23.75	17.50	15.00	9.38	100
Increasing valuation of coastal lands and economic benefits to the owners	35	38	32	26	17	12	160	21.88	23.75	20.00	16.25	10.63	7.50	100
Tourism embankment diluting the exposure, vulnerability and risk of coastal hazards	19	29	33	34	27	18	160	11.88	18.13	20.63	21.25	16.88	11.25	100
Scope to optimum utilization of coastal landscape potentiality	16	31	36	29	28	20	160	10.00	19.38	22.50	18.13	17.50	12.50	100
Average	23	33	35	30	23	16	160	14.38	20.75	21.63	18.50	14.50	10.25	100

Source: Field Survey, March-June, 2023

7.6 Other Benefits of the Bridge cum Marine Drive Construction:

Table-20: Other Benefits on the study area due to Marine Drive and Bridge Construction														
Name of Other Benefits	Magnitude of the responses/ perceptions on other benefits													
	Number of Perception							% of Perception						
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T
Administrative and institutional proper care for coastal development and management	21	30	33	28	30	18	160	13.13	18.75	20.63	17.50	18.75	11.25	100
Special care to community and areal development	18	31	37	30	23	21	160	11.25	19.38	23.13	18.75	14.38	13.13	100
Increasing institutional income through tax and revenue	36	48	36	14	15	11	160	22.50	30.00	22.50	8.75	9.38	6.88	100
Scope to proper plan, policy and programme implementation for development and management of the region	17	30	33	28	32	20	160	10.63	18.75	20.63	17.50	20.00	12.50	100
Average	23	35	35	25	25	18	160	14.38	21.72	21.72	15.63	15.63	10.94	100
Overall Average	23	33	35	29	23	17	160	14.38	20.92	21.60	17.98	14.63	10.50	100.0

Source: Field Survey, March-June, 2023

VIII. Cost-Benefit Index Assessment for Bridge and Marine Drive Construction in the Study Area:

8.1 Benefit Index Assessment for Bridge and Marine Drive Construction in the Study Area:

Different Benefits of Marine Drive & Bridge Construction	Number of Respondents							% of Respondents							Significant Weightage	Benefit Index (BI)
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T		
Development of local and regional transport and communication	37	41	59	32	23	10	202	18.32	20.30	29.21	15.84	11.39	4.95	100	7.98	BI/ BI _{B-MDC} = 68.24%
Having more easily accessible of the place	47	51	46	23	21	14	202	23.27	25.25	22.77	11.39	10.40	6.93	100	7.63	
Saving the excessive transport costs	38	48	43	33	27	13	202	18.81	23.76	21.29	16.34	13.37	6.44	100	7.39	
Being more attractive having the beach & sea in hand or on the way	33	46	33	45	35	10	202	16.34	22.77	16.34	22.28	17.33	4.95	100	6.54	
Increasing more tourist pockets on the way	25	38	49	48	31	11	202	12.38	18.81	24.26	23.76	15.35	5.45	100	6.54	
More entertaining and adventuring scope than previous	34	44	41	35	32	16	202	16.83	21.78	20.30	17.33	15.84	7.92	100	6.89	
Promoting the coastal rural infrastructural development	32	37	43	46	31	13	202	15.84	18.32	21.29	22.77	15.35	6.44	100	6.54	
Increasing the job/ occupational opportunity	21	35	39	48	42	17	202	10.40	17.33	19.31	23.76	20.79	8.42	100	5.70	
Developing the status of life style and livelihood	36	40	41	39	35	11	202	17.82	19.80	20.30	19.31	17.33	5.45	100	6.19	
Good luck for local & regional development	28	38	46	46	32	12	202	13.86	18.81	22.77	22.77	15.84	5.94	100	6.84	
Average	33	42	44	40	31	13	202	16.39	20.69	21.78	19.55	15.30	6.29	100	6.824	
N.B.:																
* Respondents are household representatives, shopkeepers, hoteliers, transport workers, suppliers, servicemen, travelers, businessmen, etc.																
** BI = 0-20% = Very Low Benefit, BI = 20-40% = Low to Medium Benefit, BI = 40-60% = Medium to High Benefit, BI = 60-80% = High to Very High Benefit & BI = 80-100% = Very High to Absolute Benefit																
Source: Field Survey, March-June, 2023																

The table 21 shows the assessment Benefit Index for Bridge Construction and Marine Drive Project in the study area. Here not only the households, but also the respondents from tourism signatures like hotels, restaurants, lodge, shops, etc., tourists, local businessmen, fishermen, farmers, fish farmers, etc. have been considered to take the perceptions for benefit analysis and assessment. Qualitative data analysis estimates the Bridge and Marine Drive Construction Benefit Index (BI_{BMD}/BI) as 58.86 which are moderate to higher in trend. Hence, it is clear that marine drive has been an important way for not only transport and communication development, but also livelihood improvement. In fact, this beneficial background should be more emphasized in magnitude since it is an intermediate coastal stretch in between Digha and Contai, these two important coastal urban centres.

8.2 Cost Index Assessment for Bridge and Marine Drive Construction in the Study Area:

Different Costs of Marine Drive & Bridge Construction	Number of Respondents							% of Respondents							Significant Weightage	Cost Index (CI)
	VH	H	M	L	VL	NR	T	VH	H	M	L	VL	NR	T		
Destroying the sand dune and green cover & diluting the beauty of coast	48	51	36	32	27	8	202	23.76	25.25	17.82	15.84	13.37	3.96	100	6.68	CI/CI _{B-MDC} = 62.21
Degrading the beach environment and diluting its beauty	36	43	46	38	29	10	202	17.82	21.29	22.77	18.81	14.36	4.95	100	6.19	
Hesitated beach travelling & chaotic beach interference	31	43	48	42	27	11	202	15.35	21.29	23.76	20.79	13.37	5.45	100	6.04	
Constructing shop here and there on and along the beach	39	46	45	32	28	12	202	19.31	22.77	22.28	15.84	13.86	5.94	100	6.44	

violating CRZ Policy															
Degrading water quality for sea bathing than before	23	41	47	45	35	11	202	11.39	20.30	23.27	22.28	17.33	5.45	100	5.50
Excessive costs of goods and other things in the place	45	51	43	32	21	10	202	22.28	25.25	21.29	15.84	10.40	4.95	100	6.88
Excessive transporting, fooding and lodging costs	36	51	42	34	27	12	202	17.82	25.25	20.79	16.83	13.37	5.94	100	6.39
Irritating behaviors of hoteliers, shopkeepers, travelers, guiders & others	31	43	45	37	34	12	202	15.35	21.29	22.28	18.32	16.83	5.94	100	5.89
Increasing fake and fraud characters in interactions	28	39	42	48	35	10	202	13.86	19.31	20.79	23.76	17.33	4.95	100	5.40
Increasing dis-looking or anti-socio-cultural activities than previous	34	37	45	40	33	13	202	16.83	18.32	22.28	19.80	16.34	6.44	100	5.74
Habitat, ecosystem, biodiversity & species diversity loss	46	49	44	30	23	10	202	22.77	24.26	21.78	14.85	11.39	4.95	100	6.88
Huge degradation of coastal environment	40	51	43	33	24	11	202	19.80	25.25	21.29	16.34	11.88	5.45	100	6.63
Average	36	45	44	37	29	11	202	18.03	22.48	21.70	18.28	14.15	5.36	100	6.22
N.B.: * Respondents are household representatives, shopkeepers, hoteliers, transport workers, suppliers, servicemen, travelers, businessmen, etc. ** CI = 0-20% = Very Low Cost, CI = 20-40% = Low to Medium Cost, CI = 40-60% = Medium to High Cost, CI = 60-80% = High to Very High Cost & CI = 80-100% = Very High to Absolute Cost															
Source: Perception Based Field Survey, March-June, 2023															

Just like Benefit Index assessment, Cost Index for bridge and marine drive construction (CI/CI_{B-MDC}) has also been estimated in the same way. 202 respondents from various fields have given their perceptions on different costs regarding marine drive and mass tourism in the study area. The result (table 22) shows the Cost Index as 62.21 which is slightly lower in magnitude. But it's assessed that environmental costs are higher than human costs here. In fact, Benefit Index is a little bit of higher than Cost Index due to regional development. Both indices are more or less equivalent signaling the alarm from costs and wishes from benefits. So, due to the Shaula Bridge and marine drive construction, both areas are important for not only the development of livelihood, but also the regional growth. But, environment and ecology must have to consider in both cases as developmental wings.

IX. Environmental Impact Assessment (EIA) for Bridge Construction:

In this research, an interaction matrix method was applied which was developed based on the project activities and environmental components, in order to identify the probable impacts on environmental components. The bridge construction project activities are divided into three stage such as pre-construction, construction, and operation and maintenance. In the pre-construction stage, activities have been included land acquisition and development of resettlement sites, besides this; in construction stage, activities have been comprised construction of the main bridge, River Training Works (RTW), construction of approach roads, construction of bridge end facilities, construction of yards and camp, and the post-construction activities include operations and maintenance of the project. On the other hand, environmental components are classified into three parameters such as physical components, biological components, and socio-cultural components.

9.1 Procedure for Assessing Environmental Impacts:

In order to, assess impacts first of all weighting the environmental components to the overall environment which was based on the consultation among the environmental impact assessment expert members. The weightage of environmental components varies from 1-5 that has been based on the importance of the component in the project setting. Secondly, the degree of impacts on environmental components due to project activities has been measured by qualitative consultations of EIA expert members and the concept and environmental setting of the similar large project. Based on the information and expert opinion, the degree of impact is classified as positive and negative and the impact level is 0- significance or nil, 1- low, 2- medium, 3-high (Table 23). Thirdly, assessing the nature of the impacts on environmental components based on temporal (Short/ Long term and mitigability extent (Partially/ Fully mitigable). Moreover, assessing composite rating value to environmental components based on three variables such as degree, duration, and mitigability of impact (Table 23).

Table-23: Prioritization Procedure for Assessing Key Environmental Impacts					
Negative Impact					
Composite value	Degree of impact	Temporal		Mitigation	
		Short-term	Long-term	Partiality	Fully
-1	Low (-1)	√		√	√

-2	Medium (-2)	√	√	√	√
-3	High (-3)		√	√	
Negative Impact					
Composite value	Degree of impact	Temporal		Mitigation	
		Short-term	Long-term	Partiality	Fully
+1	Low (+1)	√			
+2	Medium (+2)	√	√		
+3	High (+3)		√		

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

Furthermore, calculating the impact value for environmental component by using following equation-

$$\text{Impact value} = \text{Weightage value} \times \text{Composite rating scale} \dots\dots\dots (1)$$

Finally, for prioritization and categorization of impacts using the following scale:

Table-24: Prioritization and Categorization of Impacts		
Negative Impact	Impact value	Remarks on Category
Low Negative Components	-1 to -5	Yellow category
Moderately Negative Components	- 6 to -10	Pink category
Highly Negative Components	> - 10	Red category
Negative Impact	Impact value	Remarks on Category
low positive components	1 to 5	Light Green category
moderately positive components	6 to 10	Dark Green category
highly positive components	> 10	Blue category

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

9.2 Data Collection Procedure:

Deriving accurate information is highly depended on the survey method. Data were collected during the months from February, 2022 to June, 2023. Areconnaissance survey was carried out to ascertain the primary idea about the project area. Data were collected from primary and secondary sources. Primary data were collected by Household questionnaire survey, Consultation meeting of expected affected people at project area, Expert Consultations, Focus Group Discussions (FGD), and key informants interview method. Firstly, a semi-structured questionnaire was used for collecting the information of people who are directly or indirectly affected by the proposed project. A total 160 household and various occupational character survey was done for knowing the information of the affected people. Secondly, several consultations discussion was arranged in order to find out the amount actual damage of proposed project and how people will benefit from the project. Thirdly, a various expert consultation meeting discussion was arranged with the expert of this field. Expert was consulted through individual and group meetings including the project panel of experts, selected individuals, and an organization with professional knowledge of EIA process. The meeting was conducted at an early stage of EIA. Expert's consultation has involved the Professionals who have specialized knowledge in wildlife, ecology, river morphology etc. and senior government officials who are responsible for reviewing the EIA report and making decisions on the environmental clearance. Finally, a key informant is an individual who has a great depth of knowledge about a specific field and can offer perceptive information to the researcher relate to the research questions and problem-solving suggestions related to any problem. [9] [15]

Secondary data were collected from different relevant authentic sources, bridge construction authorities, construction manager, project manager, chief engineer of this bridge construction project, local government and engineering department and from relevant articles. On the other hand, the baseline environmental condition of the project area was drawn according to the information collected from secondary and primary data sources through literature review, field investigations, and consultations with different stakeholders. [9] [15]

Table-25: Environmental Component Assessment								
Project Activities	Environmental Components							
	Physical Components						Biological Components	
	Water	Air	Soil	Noise	Erosion / Scour	Waste	Flora Diversity	Fauna Diversity
Pre-Construction Phase								
Land Acquisition							-15	-15
Mobilization of construction equipment's and vehicles		-3		-4				
Clearing of sites						-3	-15	-5
Removing of top soils					-4		-5	
Earth filling and compaction	-3		-3	-4	-4			-15
Plantation		6						
Construction Phase								
Main Bridge								
Mobilization of construction equipment's and vehicles		-3		-4				
Dredging of channels to bring barges	-3					-3		-10
Construction of sub-structure	-6			-12		-3		-15
Construction of superstructure	-6	-3		-8		-3		
Disposal of wastes	-6		-3			-6		-5
River Training Works								

Mobilization of construction equipment's and vehicles		-3						
Dredging for slope preparation	-6	-3		-4	-4	-3	-10	-15
Construction of embankment	-6	-6		-8			-15	-5
Disposal of dredge materials	-6		-3		-8	-9		-15
Approach roads								
Mobilization of construction equipment's and vehicles		-3		-8				
Clearing of sites				-4		-6	-15	-5
Removing of top soils					-4	-3	-5	
Earth filling and compaction for road embankment	-3	-3	-3	-4	-4	-6	-5	-5
Black carpeting (bituminous carpet)	-3	-6	-3			-3		
Construction of road structures	-3	-6	-3	-4	-4	-3		
Waste disposal	-3		-3			-3		-5
Bridge end facilities								
Mobilization of construction equipment's and vehicles		-3		-8				
Clearing of sites						-3	-10	-10
Removing of top soils					-4	-3	-5	
Earth filling and compaction	-3	-3	-3	-4	-4		-5	
Development of superstructure				-4		-3		
Waste disposal	-3		-3			-3	-5	-5
Construction yards								
Dredging for development of Construction Yards	-6	-3		-4	-4	-3	-10	-15
Mobilization of construction vehicles/materials	-3	-3		-8				
Clearing of sites						-3	-10	-5
Removing of top soils					-4	-3	-5	
Earth filling and compaction			-3	-4	-4		-5	
Operation of Construction Yards	-9	-9	-3	-8	-8	-3	-5	
Operation & Maintenance Phase								
Main Bridge	-3	-3	-3	-8			15	
River Training Works			-3		12			
Approach roads	-3	-9	-3	-8		-3	15	
Bridge end facilities				-4		-3		

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

Table-26: Socio-cultural Component Assessment

Project Activities	Socio-cultural Components						
	Land Acquisition & Resettlement	Land Use	Agriculture	Health, Safety and Hygiene	Employment	Gender	Transport / Road Accidents
Pre-Construction Phase							
Land Acquisition	-15		-12		-8	-3	
Mobilization of construction equipment's and vehicles							-4
Clearing of sites			-12	-5	4	3	
Removing of top soils			-4				
Earth filling and compaction		-2	-4	-5	4	3	
Plantation		4					
Construction Phase							
Main Bridge							
Mobilization of construction equipment's and vehicles							-12
Dredging of channels to bring barges				-5			
Construction of sub-structure				-5	8		
Construction of superstructure				-5	8		
Disposal of wastes			-4				
River Training Works							
Mobilization of construction equipment's and vehicles							-12
Dredging for slope preparation				-5	4		
Construction of embankment					4		
Disposal of dredge materials		-6	-4		4	3	
Approach roads							
Mobilization of construction equipment's and vehicles							-4
Clearing of sites			-12		4		
Removing of top soils			-4		4	3	
Earth filling and compaction for road embankment		-2	-4	5	4	3	
Black carpeting (bituminous carpet)				5	4	3	
Construction of road structures		4	-4	5	8	6	
Waste disposal		-2	-4				
Bridge end facilities							
Mobilization of construction equipment's and vehicles							
Clearing of sites			-12	-5	4	3	
Removing of top soils			-4				
Earth filling and compaction		-2	-4	-5	4	3	
Development of superstructure		6		-5	4	3	
Waste disposal		-2					
Construction yards							
Dredging for development of Construction Yards				-5	4		
Mobilization of construction vehicles/materials							-8
Clearing of sites			-12	-5	4	3	

Removing of top soils			-4				
Earth filling and compaction		-2	-4	-5	4	3	
Operation of Construction Yards		6		-10	8	6	-4
Operation & Maintenance Phase							
Main Bridge					4	3	12
River Training Works					4	3	
Approach roads					8	6	12
Bridge end facilities					4	3	

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

9.3 Quantification of environmental impact:

Impact assessed based on different environmental impact parameter was evaluated assigning score ranging from 0 to ± 5 for both positive (+) and negative (-) impacts. Changes of environmental parameters consider as i) severe (+5 or -5), ii) high (+4 or -4), iii) moderate (+3 or -3), iv) low (+2 or -2), v) very low (+1 or -1), vi) no change (0). Method of assessing environmental impact value (EIV) are estimated and calculated by using following equations (RPT-NEDECO-BCL, 1989; Wilson, 1998) as follows:

$$EIV = \sum_{i=1}^n vi \times wi$$

Table-27: Calculation of value of ecological impact in the bridge construction site			
Ecological parameters	RIV*	DoI**	Individual EIV***
Loss of vegetation	23	0	0
Water pollution	16	-3	-48
Soil pollution	7	-2	-14
Loss of fish habitat	12	-2	-24
Plantation	20	+2	+40
Total value of ecological impact			-46

Note: *RIV = Relative Impact Value, **DoI = Degree of Impact, ***EIV = Environmental Impact Value.

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

Table-28: Calculation of value of physicochemical impact in the bridge construction site			
Physicochemical parameters	RIV*	DoI**	Individual EIV***
Erosion and siltation	18	0	0
Surface and ground water	20	-1	-20
Sound pollution	20	-2	-40
River excavation	15	+1	+15
Air pollution	10	-2	-20
Total value of physicochemical impact			-65

Note: *RIV = Relative Impact Value, **DoI = Degree of Impact, ***EIV = Environmental Impact Value.

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

Table-29: Calculation of value of socio-cultural impact in the bridge construction site			
Socio-cultural parameters	RIV*	DoI**	Individual EIV***
Health facilities	15	+1	+15
Population and communities	30	+1	+30
Socioeconomic conditions	18	+1	+18
Current use of lands/ resources	20	-1	-20
Cultural heritage	8	0	0
Total value of sociocultural impact			+43

Note: *RIV = Relative Impact Value, **DoI = Degree of Impact, ***EIV = Environmental Impact Value

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

Table-30: Calculation of value of human interest impact in the bridge construction site			
Human interest parameters	RIV*	DoI**	Individual EIV***
Land use change	5	-1	-5
Loss of agricultural land	15	-1	-15
Road communication	30	+2	+60
Employment opportunity	6	+3	+18
Economic development	13	+1	+13
Total value of human interest impact			+71

Note: *RIV = Relative Impact Value, **DoI = Degree of Impact, ***EIV = Environmental Impact Value

Source: Field Survey Data and Authorized Secondary Data [9] [15], 2021-2023

$$\text{Total environmental impact value, EIV} = \sum_{i=1}^n vi \times wi = (-46-65+43+71) = +3$$

X. SWOT Index Analysis and Assessment:

Table-31: SWOT Index Analysis and Assessment						
SWOT	SWOT Indicators	Perception Score (%)	Weightage (as per 5-Point Likert Scale)	Gravity Score	SWOT Specific Indices	SWOT Index
Strengths (S)	Popularity of the adjacent landscape and destinations	84.47	4.0	3.38	Strength Specific Index (SSI) = 3.19	(SWOT D) = 0.86544 (86.54%)
	Higher tourist arrival and flow	81.23	4.0	3.25		
	Increase in transport-communication facility	90.45	4.5	4.07		

	Increasing opportunity to travel and tourism	85.68	4.5	3.86		
	Emerging and Integration of different economies	77.38	3.5	2.71		
	Encouraging the variety of culture by tourism	72.54	3.5	2.54		
	Upgrading standard of living	71.43	3.5	2.50		
Weaknesses (W)	Unsustainable recreational facilities	81.34	4.0	3.25	Weakness Specific Index (WSI) = 3.35	
	Unsustainable waste management system	87.56	4.0	3.50		
	Unplanned development of tourism	93.45	4.0	3.74		
	Increasing crime rates and anti-social activities	76.32	4.0	3.05		
	Changing traditional culture	81.89	4.0	3.28		
	Fabricated ecosystem, fragmented habitats & mining environmental health	82.46	4.0	3.30		
	Overuse, misuse and abuse of local resources	83.27	4.0	3.33		
	Locational advantage	75.78	3.5	2.65		
Opportunities (O)	Availability of unexplored virgin beaches	73.52	3.5	2.57		
	Potentiality to introduce ecotourism	59.76	3.0	1.79		
	Funds generated from tourism activities can be used to promote better infrastructure and facilities	67.84	3.5	2.37		
	Increasing employment opportunities	73.81	4.0	2.95		
	Increasing investment from different ends	70.26	3.5	2.46		
	Economic and regional development	74.46	3.5	2.61		
	Strategic development for advanced tourism	68.49	3.5	2.40		
	Integrated coastal development and management	68.63	3.5	2.40		
Threats (T)	Natural habitat and biodiversity loss	83.74	4.0	3.35	Threat Specific Index (TSI) = 3.19	
	Pollution, degradation and crisis	80.15	4.0	3.21		
	Estuarine and coastal unsustainability	76.32	4.0	3.05		
	Increasing coastal exposure, vulnerability and risk	82.62	4.0	3.30		
	Defeating traditional economies to quick/ mass tourism	80.65	4.0	3.23		
	Depriving coastal communities to immigrated communities and culture	74.89	4.0	3.00		
N.B.: SWOT Index (SWOTI) = 0-20% = Lower Landscape Susceptibility, SWOTI = 20-40% = Low to Moderate Landscape Susceptibility, SWOTI = 40-60% = Moderate to High Landscape Susceptibility, SWOTI = 60-80% = High to Very High Landscape Susceptibility and SWOTI = 80-100% = Very High to Absolute Landscape Susceptibility.						
Source: Field Survey and Data Analysis, 2023						

XI. Major Findings:

- ❖ Shaula Bridge is the unique transport interlinkage in between two coastal stretches, Junput Sector and Mandermoni Sector on and along the Contai as well as Midnapore coast under DSDA.
- ❖ Bridge construction was proposed and started under the institutional incentives as Marine Drive Project by the Respected Chief Minister, Mrs. Mamata Banerjee in 2018. [16] [17] [18] [19] [20] [21] [22]
- ❖ Construction of bridge is completed and opened by institutional and authorized characters on May, 2022. [16] [17] [18] [19] [20] [21] [22]
- ❖ Bridge is about 1.45 km in length and 20 metre average width on the extension.
- ❖ Bridge physically interlinkages two coastal villages on two different coastal stretches on Contai cost, i.e., Dakshin Purushottampur village at the south on Mandermoni stretch under Kalindi GP of Ramnagar-II CD Block and Serpur Jalpai village on Junput Stretch under Nayaput GP of Contai-I CD Block in Purba Medinipur district.
- ❖ Shaula Bridge has been constructed and extended over Pichhabani Rive nearby its estuary to Bay of Bengal.
- ❖ Shaula Bridge and its adjacent areas show the typical coastal rural landscape featured by fishing and fish farming blue economies.
- ❖ Most of the families of the study area are poor, marginal and middle class categories since they are mostly related to the primary economic activities.
- ❖ CRZ of this region has been characterizing by fishing and tourism infrastructure mainly with time.
- ❖ Small and marginal fishermen who fishing near the shore is struggling to market their catch with new norms and short time available for sales. The vendors have to sell their fish at lower rates nearly 30 per cent lower.
- ❖ Tourism infrastructure, specifically huge amount of hotels, lodge and restaurants, have been developing within 0-200 metre from the shoreline as well as no development zone here.
- ❖ This bridge is not efficient from the view point of transport and communication, but also to the livelihood and socio-economic development of the region.
- ❖ Tourism has been developing in the region with the help of bridge construction and marine drive project implementation
- ❖ Domination of outsiders with the help of local middlemen, representatives, administrative characters and leaders has been emphasized in case of haphazard, illegal, unscientific and unplanned encroachment and development of this coastal landscape in the study area.
- ❖ Plan-policy-programme-practice gaps and prime character-planner-policy maker-politician-practitioner-public conflicts have been typical for this illegal growth of tourism and other human infrastructure throughout the coastal landscape.
- ❖ Govt and administrative roles are very much controversial whereas a lot of notifications have been drawn from the different platforms of justice at different time.
- ❖ Environmental costs are very much and equivalent to human benefits. Hence, it should be undertaken to manage from the institutional and authorized sites.

- ❖ Safety and security of tourists and travelers should be emphasized from govt. and administrative ends since the socio-cultural environment of the bridge site has been degraded by different dislooking, anti-social and crime activities.
- ❖ Local people and local resources have been tremendously affected by the quick unexpected growth of bridge construction, marine drive project implementation and emerging tourism industry here.
- ❖ Among all the blue economies, tourism has been leading one replacing or having equivalent to fishing and fish farming in the study area.
- ❖ Occupational shifting towards tourism leads to the conflict among blue economies throughout the study area.
- ❖ Most of the local people, leaders, representatives, local administrators, and quick developers don't have any basic or detailed knowledge about CRZ, its violation and related impacts on man and nature.
- ❖ Short term economic benefits of CRZ violation draw out the long term impacts as well as massive human and environmental costs in the region, i.e., costs are very much higher than that of the benefits from rapid and illegal tourism growth here.
- ❖ Coastal vulnerability is higher at the estuary sections and CRZ occupied hotel sectors reflecting poor managements there.
- ❖ No specific highlight and consideration for sustainable development of local CRZ are reflected from different responsible ends for this region.
- ❖ Lack of database and databank from project or research is also well reflected for understanding such an important issue in this region.
- ❖ In SWOT analysis, strength and opportunities are sufficient, but weakness and threats are also high for poor governance, administration and management. Hence all dimensions should be emphasized for its sustainability.

XII. The mitigation measure of potential negative impact during the construction of the bridge over Pichhabani River in Shaula:

Table-32: The mitigation measure of potential negative impact during the construction of the bridge over Pichhabani River in Shaula	
Negative impacts	Proposed mitigation measures
Solid and liquid waste from the labor camp	<ul style="list-style-type: none"> • Labor camp should be constructed at a distance from the water body, • Avoid productive land and away from the settlement during the selection of land for the setup of labor camp, • No solid and liquid waste discharge into the water bodies, • Instruct workers to maintain a clean environment in the camp and its surrounding area.
Air pollution	<ul style="list-style-type: none"> ❖ Fit vehicles with appropriate exhaust systems and emission control devices, ❖ Maintain vehicles and construction equipment in good working condition including regular servicing, ❖ Operate the vehicles in a fuel-efficient manner, ❖ Impose speed limits at 20 km/hour on vehicle movement at the worksite to reduce dust emissions, ❖ Construction equipment causing excess pollution (e.g. visible smoke) will be banned from construction site immediately prior to usage, ❖ Water spray to the dry earth/ material stockpiles, access roads and bare soils as and when required to minimize the potential for environmental nuisance due to dust, ❖ Stored materials such as: excavated earth, dredged soil, gravel and sand shall be covered and confined to avoid their wind drifted, ❖ Restore disturbed areas as soon as possible by vegetation.
Noise pollution and vibration	<ul style="list-style-type: none"> • Create noise barrier and consider the minimum noise levels at sensitive receptor sites (e.g. school, mosque, temple, health center etc.), • The stone breaking machine should be confined within a temporary shed so that noise pollution could be kept in minimum, • Protection devices (ear plugs or ear muffs) shall be provided to the workers operating in the vicinity of high noise generating machines during construction, • Construction equipment and vehicles shall be fitted with silencers and maintained properly, • Instruction to the drivers to avoid unnecessary horn.
Surface and groundwater pollution	<ul style="list-style-type: none"> ❖ Any wastes should not be throwing into the river other than dump into the designated waste dumping area, ❖ Construction work should be preferred during dry season, ❖ Store the oil and petroleum product in a separate location cover by a concrete structure.
Soil pollution	<ul style="list-style-type: none"> • Avoid the productive land, agricultural land, archaeological sites, protected area, forest area, natural habitat etc., • Soil from the fallow land should be used in earthwork in approach road or by dredge soil from the river bed, • Re-vegetation the exposed area as early as possible to reduce the soil erosion.
<p style="text-align: center;">• Source: Author's Own Composition based on literatures [9] [15] [23] [24] [25] [26] [41] and survey</p>	

XIII. Proposed Environmental Management Plan:

Table-33: Proposed Environmental Management Plan			
Significant Impacts	Proposed Mitigation Measures	Number of Respondents	% of the Respondents
Flora diversity	1. Plantation should be done around the bridge and resettlement site.	140	87.34
	2. To select fast-growing tree species for planting in the bridge approach roads and resettlement site.	134	83.45
	3. The contractor should plant a significant number of tree and grasses along open spaces of the roadside.	119	74.56
	4. Disposal of materials in accordance with the dredge material management plan	131	81.91
	5. Establishment of Pichhabani projected sanctuary by the project contractor/ authority to mitigate the significant impact	123	76.57
	6. Plantation or green areas will be developed around the bridge end facilities and within the open space	119	74.58
Fauna	1. The contractor should be dug new ponds in resettlement site and tries to increase aquatic	105	65.48

diversity	habitat		
	2. Disposal of materials in accordance with the dredge material management plan.	121	75.89
	3. Establishment of Pichhaboni projected sanctuary by the project contractor to mitigate the significance impact	132	82.34
	4. The contractor will dig the similar pond in resettlement area and also ensure to increase aquatic habitat.	123	76.82
	5. Inspect any area of a water body containing fish that is temporarily isolated for the presence of fish, and all fish shall be captured and released unharmed in adjacent fish habitat	94	58.92
Noise	1. The workers in construction yard should be required to use ear-plugs to offset the effect as noise management at the source levels are expected to be difficult except for the generators where the use of muffler would reduce the noise	128	80.26
	2. Install temporary noise control barriers where appropriate.	118	73.67
	3. In order to reduce the underwater noise from pile driving, use vibratory hammer rather than impact hammer. Beside this, use a hydraulic hammer if the impact driving cannot be avoided. In addition to mitigating the Hilsa migration and porpoise breeding schedule monitoring will maintain and if possible delay the pile driving.	109	67.88
Agriculture & Aquaculture	1. The contractor/ authority should provide compensation in accordance with resettlement action plans.	110	68.94
	2. Bring fallow lands under agricultural cultivation.	109	67.89
	3. Provide training program for the farmers and technical support to them.	105	65.58
	4. To formulate agriculture and aquaculture development plan to increase crop production.	96	59.84
Transport and road accident	1. When construction materials will bring on land transport the construction vehicle will ensure speed limits which will not create accidental risk in public road and construction site.	126	78.92
	2. Contractor/ Authority should be provided adequate signage, barriers, and flag persons for traffic system.	122	76.48
	3. Whereas, the local road will damage badly due to high load construction vehicles moving, so the contractor ensure interrupted vehicles moving as well as temporary construct bypass for reduce local road traffic congestion.	119	74.58
	4. Repair the damaged local roads to their original condition after project completion.	118	73.89
	5. On the other side, when construction equipment's and materials will transport by water channel, ensure less dredging the river bed and char land as well as the dredging materials will release in water in accordance with dredging material management plan.	121	75.69
Air quality	1. The contractor/ authority should implement the air quality management plan.	125	78.32
	2. Cover hauls vehicles carrying dusty materials in construction site.	111	69.58
	3. The contractors should be responsible for careful handling and storages of materials and operation of the equipment in order to reduce the air pollution including dust.	127	79.34
	4. Special attention must be given in storage and handling of petrochemicals in order to avoid environmental hazard and risk.	116	72.39
Water Quality	1. Less dredging the river bed and char land, as well as the dredging materials, will release in water in accordance with the dredging material management plan	111	69.09
	2. Unused concrete should not be disposed into the river water.	125	78.32
	3. Implement waste management plan on the construction yards.	122	76.12
	4. All construction materials should be reused, recycled and properly disposed of.	120	74.78
N = 160		Source: Field Survey, 2023	

XIV. Recommendation from Research End:

Following are some of the suggestions for the improvement of the CZMP and thereby the coastal environment.

- ❖ **Regulation and Enforcement:** In order to ensure long-term conservation of the coastal habitats and the sustainable use of the coastal resources, it is pertinent to regulate the developmental activities in the coastal zone. As the coasts offer wide variety of opportunities for various interest groups – from tourism and resort developers to industrial and land developers – there is every chance for the traditional and artisanal communities to be side tracked and marginalised. Since the real stakeholders are identified in the CRZ Notification to be the fishing communities, the regulation as such should be made applicable to all other interest groups. Different rules and regulations from institutional ends for maintaining, monitoring and management of the bridge should be followed from local bodies and characters under the supervision of local administration in time. [30], [31], [32], [33], [34], [35], [36]
- ❖ **Research:** It is important that academics and researchers are involved not only to take stock of the present situation of our coasts, but also to investigate the pros and cons of every single human intervention and the consequent impact to the natural systems. [37] Even the physical and human geography of our coasts is understood poorly and the information available are so fragmented. Moreover, coastal problems and phenomena are inadequately understood. Therefore, it is desirable to develop an in-depth Coastal Information System. More research should be introduced and implemented regarding the cost-benefit analysis and newer planning and modeling for more sustained bridge construction in terms of regional development along with tourism upgradation.
- ❖ **Co-ordination:** A proper CZM requires co-ordination of various state agencies and NGOs. It should be only through coordinated efforts that activities on our coasts could be regulated. Often responsibilities of various agencies overlap, resulting in actual or potential conflicts among them, or in some cases, it is not clear which agency is responsible for the

management of some activities that result in adverse impacts on coastal resources. [37] Therefore, due to these jurisdictional gaps or overlaps there should be coordinated efforts especially among Urban Development Authorities, Municipal Corporations, Public Works Departments, Industrial Financiers and Development Corporations, Tourism Development Corporations, fisheries Departments and departments dealing with Ports and Harbours. Fisheries Co-operatives, MPEDA etc.

- ❖ **Education:** Educating the coastal communities is an important component for a sound Coastal Zone Management. So far the state initiatives were only in raising the literacy. [37] But being literate alone is not enough. To improve their living conditions and to be equipped to face external threats from Developers, it is imperative to be educated. Moreover, the benefits of any management initiatives would be successful when education programs mobilize public support.
- ❖ **Plan and Policy Development:** CZM bears fruit only when planning efforts focus on developing objectives and implementing actions for the coastal problems. Area-specific Management Plans referring to existing legislation etc. should be the priority. Unless plans are formulated as consequence to the coastal conservation policy, the validity of such activities and their legitimacy will be questioned.
- ❖ **Role of Local Bodies:** The 72nd and 73rd Amendments to the Indian Constitution consider the issues of larger involvement of Panchayati Raj Institutions in management of natural resources. The decentralization so far meant only political decentralization and not the issues of natural resource management by Panchayati Raj Institutions. [37] Making use of the 11th schedule to the constitution (73rd Amendment) Act 1992, coast conservation should be vested and management options should be worked out with local governing bodies. Since the bridge is local, locality and local bodies should be attempted at first for maintaining the bridge environment for the landscape sustainability.
- ❖ **The need to appoint a Coastal Zone Management Authority** in each Coastal State to guide and direct the Integrated Coastal Management Plan and implement the CRZ guidelines. In this case development and management of these bridge adjacent areas should be considered and emphasized under integrated coastal management system maintaining the CRZ policy strictly.
- ❖ **The traditional fishing community having traditional and customary rights** should be accommodated in the CRZ-II and III as far as their residences and work places are concerned. The CRZ Notification should be amended to this effect. [37] Tourism and fishing with traditional marine aquaculture should be emphasized jointly in self of regional development. Hence, different govt. and organizational incentives should be introduced and implemented for all the blue and green economies which are existed conventionally and have been developing in time

XV. Conclusion

The Shaula bridge project has been proposed, constructed and implemented by the government of West Bengal for not only increasing the transport-communication system in Junput-Mndermoni Tourism-fishing corridor over Midnapore coast in Bengal, but also to emphasize and dignify the coastal tourism-travelling and entertaining throughout the region. Under the Digha-Shaula Marine Drive Project Shaula Bridge is the transport infrastructural catalyst which has stimulated the local as well as regional mass tourism along with inspiring the local and regional coastal development in time. Although survey cum study has been done on the bridge and two adjacent villages, but this bridge is not important only to these two villages, but significant lifeline to regional livelihood and economy. The project subject to its nature of activities falls under Red category as per environmental impact as well as cost assessment as per EIA rules. Hence, it has been required to maintain proper and regular environmental monitoring and management by the fixed assessment committee in time. In fact this was proposed and started to construct in 2018 and completed and opened at the first half of 2022 by the concerned authority, institution and prime characters of the region and state. DSDA has maintained a vital role to supervise the construction project throughout the time. As per prolonged demand as well as requirement, this bridge has been constructed from the institution positively, although the local demand was from transport-communication and socio-economic background, but govt. was to consider it from most effective transport-travel-tourism perspectives under one DSDA coastal marine drive envelop.

In fact, to get the environmental clearance certificate from DoE, a detailed environmental impact assessment report, as well as environmental management and monitoring plan, were formulated in the constructing procedure. From this mandate, a detailed environmental impact assessment report as well as environmental management and monitoring plan was formulated. As per EIA report there are both positive and negative impacts due to the construction of the bridge over the Pichhaboni River nearby its mouth. The significant negative environmental and social impacts have been noticed when the land is acquired for starting the project construction works as well as at the time of resettlement site development. Alongside, the traffic safety risk such as accidents, congestion has been amplified during the mobilization of construction equipment and materials by using the local road. On the other side, the flora and fauna diversity have been experienced a significant negative impact because of clearing the project site for the development of resettlement site, construction of approach roads, construction yards, and construction of

bridge end facilities. Furthermore, at the time of pile driving for construction of the main bridge, a high underwater noise was generated which had a high negative impact on the aquatic habitat in the river. Besides, the activities for preparing the construction materials and at the time of construction of bridge superstructure, a high amount of noise was produced which had a high negative impact on the health of workers as well as the people of the nearby community. Moreover, at the time of river training works and construction of substructure such as pile driving, a high amount of dredge materials were produced and improper disposal of this waste has deteriorated the surface water and soil quality. As a result, the aquatic habitat in the river and agricultural land beside the project area faces serious negative impact. On the contrary, the air quality is deteriorated during the operation of construction vehicles and equipment at the construction site and the activities of construction yards as well as the construction of bridge substructure and superstructure. Nevertheless, this bridge construction project has significant positive impacts for instance; at the time of construction, a huge number of people got short-term employment opportunity. Additionally, when the project is completed the land use pattern of the project area is also changed. Besides this, the vehicles get more trips, so the people easily reach their destination. Moreover, the economic condition in this area has been rapidly developed along with its transport as well as infrastructural development. The findings of this research explored that the bridge construction project is featured by a significant negative impact due to some construction activities occupying several sensitive fluvio-coastal features and habitats here. Therefore, the expertise thoughts from this research have been formulated for the environmental management plan in different phases (preconstruction, construction, and operation and maintenance) for mitigating the adverse environmental and social impacts. Besides this, a successful environmental monitoring plan has been provided for monitoring the air, water, and noise quality; flora and fauna diversity, waste, traffic safety risk, plantation, and health safety during the construction and operation and maintenance stages. This Shaula bridge construction project has overall positive impacts leading huge socio-economic benefits of the region and some negative impacts, specifically towards environment and fluvio-coastal susceptibility. Most of this negative impacts are mainly construction related which has been recovered and remaining may be mitigated by the successful implementation of the environmental management and monitoring plan. But, it's the ground truth that this bridge construction under the praiseful institutional marine drive project has drawn a new lifeline to local as well as regional livelihood and development.

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