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ESTABLISHING AN INFORMATION FUSION CENTRE (IFC) AS A STRATEGIC ENABLER FOR MARITIME DOMAIN AWARENESS (MDA) IN BANGLADESH: A FUNCTIONAL AND GOVERNANCE PERSPECTIVE

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Abstract: Maritime security underwent a paradigm shift in the post-9/11 scenario, revolutionising the term 'MDA' to ensure maritime safety, security, economy, and environmental preservation from emerging non-traditional security (NTS) threats. This triggered the global adoption of information technology (IT), such as the IFC, to know what is happening in real-time, utilising artificial intelligence (AI), Satellites, and fusing various sensor inputs. MDA is crucial for Bangladesh's trade, livelihood, blue economy (BE), environment, and national interests. Bangladesh's Constitution and the maritime legislations vividly stressed the responsibility to safeguard the Maritime Domain (MD). Despite pioneering the Maritime Zones Act in the Indian Ocean Region (IOR), Bangladesh's MDA falls short in real-time technological vigilance. Besides, nearly 25 organisations including maritime ministries, government agencies, security forces, and ancillary organisations operate in Bangladesh's MD, but in isolation without any integrated Common Operating Picture (COP). Hence, developing a real-time functional maritime picture for a safe and secure MD is essential. With a vast, complex, yet aspiring MD, it is now the need of the hour for Bangladesh to formulate a 'whole-of-government' approach to enhance its MDA. This research aims to establish an integrated IFC with a COP for all the maritime agencies to ensure a comprehensive MDA. It adopted a mixed methods approach (qualitative and quantitative methods). Besides analysing secondary sources and policy papers, a primary survey of boat operator communities from coastal areas as well as seagoing Navy and Coast Guard Officers was conducted to identify bottom-up needs assessments. Key Informant Interviews (KII) of maritime experts, policy makers, and think-tanks were carried out to link the functional and governance perspectives.

Finally, a Focus Group Discussion (FGD) of IT experts was conducted to examine the feasibility of IFC in Bangladesh. Some IFC models of SE Asian countries and IOR have also been studied. The findings of this exploratory research may help the government to plan and establish an integrated IFC at the national level for all the maritime agencies to enhance the MDA of Bangladesh.

Keywords: *Maritime Domain Awareness, Information Fusion Centre, Maritime Security, Non-Traditional Security.*

INTRODUCTION

Bangladesh's extensive maritime domain (MD) in the Bay of Bengal (BoB), long perceived as a relatively stable zone, now faces growing challenges. Maritime security amidst the non-traditional security (NTS) threats, viz maritime crime, transboundary drug and human trafficking, forced sea migration, illegal, unreported, and unregulated (IUU) fishing, dumping, pollution, and natural calamities, is crucial for Bangladesh. Besides, its coastal security cannot ignore the vulnerability of maritime terrorism. Furthermore, Search and Rescue (SAR) and Humanitarian Assistance and Disaster Relief (HADR) are frequently challenged by marine accidents and natural disasters in Bangladesh. The vast sea, the extensive coast, and complex maritime activities require a robust security monitoring structure. However, Bangladesh's maritime security has shortfalls in real-time vigilance as the maritime forces and agencies depend on physical surveillance and conventional practices. Meanwhile, maritime security had a paradigm shift in the post-9/11 scenario, revolutionising Maritime Domain Awareness (MDA) for the littorals to know 'what is happening in real-time' in the MD (Goward, 2010). This has triggered the global adoption of IT using the Information Fusion Centre (IFC) to detect real-time anomalies utilising artificial intelligence (AI), Satellites, Automatic Identification System (AIS), Long Range Identification Tracking (LRIT), and fusing vigilance inputs from multiple sensors and platforms. MDA is crucial for Bangladesh's trade, livelihood, blue economy (BE), environment, and national security. Besides, Bangladesh's Constitution and the maritime legislations vividly stress the responsibility to safeguard the MD. Despite pioneering the enactment of the Territorial Waters and Maritime Zones Act in 1974, Bangladesh falls short of developing an integrated Common Operating Picture (COP) for the maritime agencies to vigil and respond. Some fragmentary efforts to incorporate

IT into maritime security are in the pipeline, but not integrated into any central network. So, developing the real-time maritime COP is essential to create a robust and comprehensive maritime security. It requires a 'whole-of-government' approach at the functional and strategic level. This research aims to assess the feasibility of establishing an integrated IFC as a strategic mechanism to enhance the MDA in Bangladesh.

SIGNIFICANCE OF THE RESEARCH

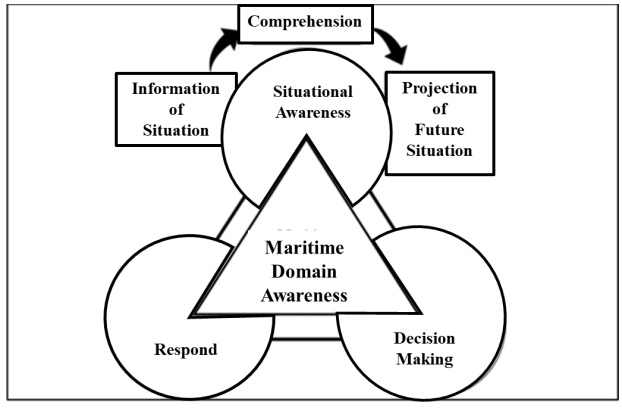
This research focuses on improving MDA. Bangladesh's MDA can be susceptible to volatile, uncertain, complex, and ambiguous (VUCA) situations without real-time detection and information sharing. The research directly impacts maritime security, the safety of the maritime community, the economy, and the marine environment. Hence, it explores the feasibility of IFC utilising IT. This research is crucial for national security, and the outcome can be a 'game changer' for Bangladesh's MD. The findings can also contribute to humanitarian assistance, maintaining good order at sea, and regional stability in the IOR.

OPERATIONALISATION OF KEY CONCEPTS

MD. Bangladesh's MD is demarcated by the Territorial Waters and Maritime Zones Act 1974 (Amended 2021), which includes the internal waters, territorial waters, the Contiguous Zone (CZ), the Exclusive Economic Zone (EEZ), and the Continental Shelf (CS). The High Sea lies beyond the EEZ.

MDA and IFC - The Connection. "MDA is the effective understanding of anything associated with the MD that could impact the security, safety, economy, or environment" (IMO, 2024). It refers to collecting, fusing, and analysing maritime data of any happenings (Situational Awareness) in 'time' and 'space' for actions (Response) (Figure 1). The MDA covers the entire maritime security matrix (Bueger, 2015), where, for information fusion, IFC is pivotal. IFC can collect borderless vigilance of multiple real-time data through Satellites, AIS, LRIT, sensors, and platforms to produce a COP (KII, Secretary, MOFA). It uses AI algorithms and data sharing software for evaluating and sharing accurate and actionable intelligence and solutions for response by enforcing agencies.

Figure 1: *MDA and IFC Connection*



Source: Endley's Situational Awarness Model, 1995

SUMMARY OF LITERATURE REVIEW AND RESEARCH GAP

MDA enables the littorals to know 'what is happening in real-time' (U.S. National MDA Plan, SI/2004). It is the cornerstone of national security (Boraz, 2009). The MD remains vulnerable if ungoverned and unpoliced without real-time vigilance (Goward & Nimmich, 2009), which is pertinent for Bangladesh. The United Nations Convention for Law of the Sea (UNCLOS) 1982 has further inspired the small littorals to vigil beyond their national waters (Doorey, 2016). If not responded timely, transboundary NTS threats can jeopardise the coastal, maritime, and national security (Pushpita, 2013). In the IT era, AIS, LRIT and Satellite applications have strengthened the traditional maritime vigilance (Metrick & Hicks, 2018). The MDA is the process to gather, fuse, and analyse data to share actionable information for response (Goward, 2009). Successfully, the IFC could develop real-time COP (Guerriero et al., 2008). In the post 9/11 scenario, various regional security initiatives, maritime conventions, and commercial applications have emerged (Yanze, 2015). Most of the reviewed literature related to MDA focused on the western, SE Asian, Mediterranean, and IO, but the BoB remained unaddressed. Meanwhile, the evolving Indo-Pacific MDA (IPMDA), Quadrilateral Security Dialogue (QUAD), Chinese Belt Road Initiative (BRI), and Indian White Shipping Agreement (WSA) are eyeing the IOR (Singh, 2022). However, a comprehensive, implementable information sharing mechanism for Bangladesh has not been researched adequately. Although Bangladesh's Constitution and

maritime legislations vividly stressed the responsibility to safeguard the MD, the integrated mechanism and governance have not been duly structured. Even the national Information and Communication Technology (ICT) plan ignored the IFC in Bangladesh (a2i, 2023), and there remains a notable research gap on the quest for establishing an integrated IFC for Bangladesh's MD. The MDA with IT is now Bangladesh's need of the hour (Alam, 2019).

RESEARCH OBJECTIVE

The primary objective is to assess the feasibility of establishing an integrated IFC as a strategic mechanism to enhance MDA in Bangladesh. It analyses the MDA gaps for addressing the NTS threats, explores IFC potentials to improve technological vigilance and information sharing, and recognises the challenges and opportunities of establishing an IFC in Bangladesh.

RESEARCH QUESTIONS

Primary Research Question

What is the implication of IFC for Bangladesh in enhancing MDA?

Secondary Research Questions

- What are Bangladesh's MDA's existing challenges and concerns?
- What mechanisms and practices are available for Bangladesh to ensure comprehensive MDA?
- What are the institutional and technological gaps of real-time MDA in Bangladesh?
- How can an IFC address the challenges posed by NTS?
- What models best suit a tailored IFC in the BoB?

RESEARCH METHODOLOGY

This research adopts a mixed methodology (qualitative and quantitative). The KII, FGD, literature, data from the primary survey, and secondary sources were transcribed and analyzed using thematic analysis to establish the research objectives.

DATA COLLECTION AND SAMPLING

In this survey, 565 respondents participated (Table 1). Purposive sampling was used to select the experienced maritime professionals and the typical maritime population. The thematic interpretation of secondary sources, viz policy papers, international studies, websites, online journals, and books/e-books is done for qualitative analysis. Visits to Secretariates, Ministries, and various maritime projects facilitated the data collection. KII of senior government officials, operational commanders, and think-tank academia generated the policy insights of the MDA framework and regulatory mechanisms. Interviews of Subject Matter Experts (SME), e.g., cloud apps companies, Defence Attaches, and officers of countries having IFC, were made through open questionnaires. The FGD with software specialists and IT experts on cyber, satellite, and data fusion was pivotal in examining the technological feasibility of IFC. A primary survey of 171 boatmen, mainly selected from the coastal belt of Chattogram, Bhola, Patuakhali and Khulna, was conducted through a structured questionnaire to ascertain the NTS threats they encounter. Another purposive survey of 352 seagoing Navy and Coast Guard Officers was made to determine the difficulties of vigilance and response without a real-time maritime picture. In addition, seven Case Studies of recurring NTS threats in national and international waters were examined to identify the evolving vulnerabilities. Finally, Model Studies of four IFCs of SE Asia and India have been done to understand the IFC mechanism. All participants during the survey, KII, and FGD have given their informed consent.

Table 1: *Respondents Participated in Survey*

Type of Respondents	Study Sample	Instrumentation
Senior Officials, Heads of Agencies, Think Tanks	**16**	**KII**
Project Directors, IFC Observers, Security Experts	**17**	**SME Interview**
Technology experts, Directors of IT, Cyber, Software	**9**	**FGD**
Enforcing Agencies (BN/BCG seagoing Officers)	**352**	**Survey 1**
Boatmen Operators (Chattogram, Bhola, Patuakhali, Khulna)	**171**	**Survey 2**
Total Respondents	**565**	

Source: Survey by Researcher

SCOPE AND LIMITATIONS

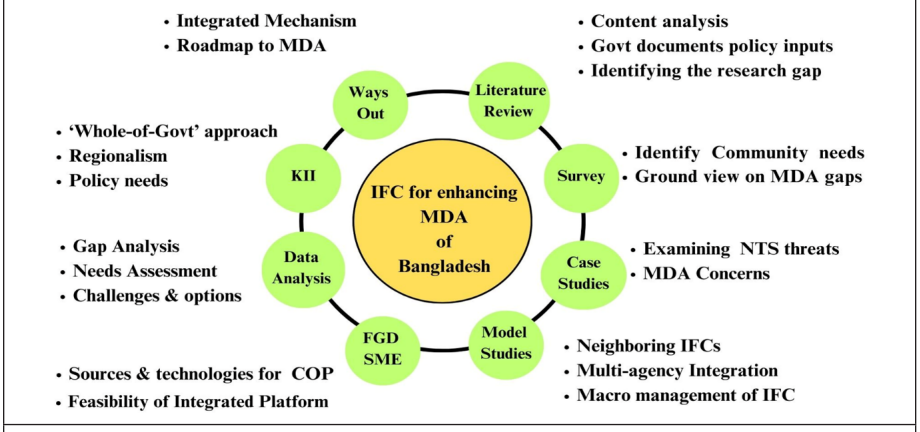
The research focused on Bangladesh's MD, particularly the BoB, and the coastal areas. Narrowing the information spectrum of the vast MD was difficult, and

limited statistical data could be collected due to time constraints. The insufficiency of the national maritime database is also felt. The survey respondents' lack of understanding of satellite apps and data fusion generated initial difficulties. Lastly, during KII, the question of why Bangladesh has not yet established an integrated IFC, even after 50 years of independence, unveiled a grey area of lead responsibility, as 25 ministries, security agencies, regulatory organs, seaports, and ancillary organisations are operating in the same MD but in isolation.

CONCEPTUAL FRAMEWORK

The research pursued the following framework to select the respondents and progress with the findings related to the research objectives (Figure 2):

Figure 2: *Conceptual Framework*



Source: Researcher's construct

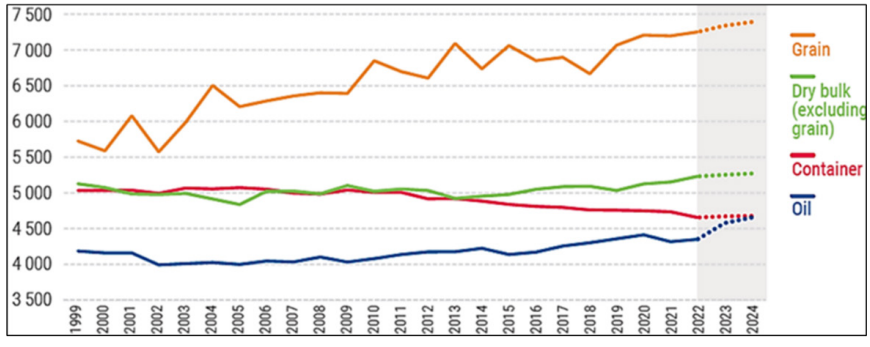
MDA IN BANGLADESH'S CONTEXT

MDA-THE IDEA

Safe Use of the Sea. The Latin concept 'Mare Liberum' of 1609, i.e., 'freedom of the seas', led to the 'common heritage of mankind' (Schrijver, 2016) for the seafaring trade by all. However, throughout history, the sea remained conducive for littorals aware of its maritime happenings for security. The oceans today are gradually becoming more complex due to the multiplication of marine traffic and evolving NTS threats. For example, the trade diversion due to the ongoing

Ukraine war, Houthi and Somali attacks has added 6,000 extra detouring miles (Table 2), thereby increasing trade costs by 35% (Duggal & Haddad, 2024), and container trade has spiked by 250% (Gruet & Josephs, 2024). The chain effect has caused port congestion and increased freight charges between Bangladesh and China from 1000 to 2500 USD (Shahadat, 2024). The disruption of Sea Lanes of Communication (SLOC) ultimately affects the maritime good order and negatively impacts trade and the economy.

Table 2: *Distance Travelled per ton of Maritime Cargo, 1999-2024*



Source: UNCTAD, Clarkson, Shipping Intelligence Network (July 2023)

MDA-Global Adoption. Traditional 'navy-centric' maritime security now also involves NTS threats to the economy, society, and the global commons. Besides, UNCLOS triggered the small littorals to vigil their Area of Interest (AOI) within and beyond EEZ for resources, trade, and SLOC (Guilfoyle, 2019). Accordingly, several information-sharing regimes emerged globally to enhance MDA (Table 3).

Table 3: *Information Sharing Regimes Emerged Globally*

Information Regime	Member Countries	Region/Focus
Common Information Sharing Environment (CISE)	300 EU countries	Global sharing
Global Maritime Environment Security (GMES)	EU and Licensed African countries	Global sharing of Earth observation Satellites
Clean Sea Net	23 EU countries and trade partners	EU-centric oil spill monitoring using Polar Satellites

Table 3: *Information Sharing Regimes Emerged Globally*		
Information Regime	Member Countries	Region/Focus
Regional Agreement for Combating Armed Robbery and Piracy (ReCAAP)	ASEAN, Bangladesh, Japan, Korea, China, India, Sri Lanka, USA, UK, Germany, Netherlands, Norway, Australia, Denmark	South East Asia-centric maritime information sharing
Djibouti Code of Conduct (DCoC)	Djibouti, Comoros, Ethiopia, Madagascar, Maldives, Mozambique, Saudi Arabia, Seychelles, Tanzania, Kenya, Somalia, Mauritius	West IO and East Africa-centric maritime information sharing
IFC-IOR	India, Australia, France, Italy, Japan, Maldives, Mauritius, Myanmar, Seychelles, Singapore, Sri Lanka, UK, USA, South Africa	IOR-centric. Bangladesh has an Observer in the IFC IOR.
Source: Researcher's findings from Websites [Online]		

CHALLENGES OF BANGLADESH'S MD

IUU Fishing. Rudimentarily, 9 million tons of fish are caught by IUU yearly (Alam, 2021). Navy Commander Flotilla West states that BN and BCG ships are frequently driving away IUU boats, but without Satellite surveillance guarding IUU entries, by mere patrolling is difficult (KII, COMFLOT West). Bangladesh ranks 59th out of 152 countries in the Global IUU Index 2023. Thus, technological vigilance is essential before the IUU crisis rings an alarm. Current Statistics of IUU fishing in the BoB are shown in Table 4.

Table 4: *Statistics of IUU in the BoB*					
Year	Origin IUU	By BN		By BCG	
		Apprehended	Driven Away	Apprehended	Driven Away
2020	India	02	823	03	-
	Myanmar	04	16	-	-
	Sri Lanka	-	-	-	-
2021	India	-	628	04	37
	Myanmar	-	46	-	-
	Sri Lanka	-	-	-	-
2022	India	-	273	37	10
	Myanmar	-	02	-	-
	Sri Lanka	-	03	-	-
2023	India	-	315	-	220
	Myanmar	-	-	-	-
	Sri Lanka	-	-	-	-
Total		06	2106	44	267
Source: BN and BCG Headquarters, 2024					

Bangladesh's NTS threats, viz armed robbery, smuggling, pollution, marine crimes, accidents, and casualties, are recurring and pose significant challenges. Frequent news appears in dailies, and many remain undetected. A few case studies of recurring maritime incidents requiring real-time monitoring are highlighted in Table 5.

Table 5: *Case Study - Recurring Maritime Incidents in Bangladesh's MD*	
Maritime Incidents	Findings
Case Study 1: Distress. 15 fishermen from a disabled trawler rescued by a BN ship after 10 days drifting (bdnews24.com, 15 Jan 2024).	Locating distress without AIS tracking is time-consuming.
Case Study 2: Armed Robbery. 10 dead bodies of boatmen found, killed at sea and kept in a trawler off Cox's Bazar (Dhaka Tribune, 23 Apr 2024).	Criminals exploit the absence of real-time detection in the unregulated sea.
Case Study 3: Marine Casualty. 39 were killed and 100 injured after a defective ferry caught fire mid-river at Jhalkathi (BBC News, 24 Dec 2021).	Unfit vessels cannot be tracked, and rescue is delayed without live monitoring.
Case Study 4: Drug Smuggling. BN seized significant drug haul U$ 10 million - smugglers rampant at sea (Vice News, 12 Feb 2015).	Tracking sea smugglers without a database and pattern analysis is difficult.
Case Study 5: Oil Spillage. Sagar Nandini-2 sank with 1.1 million litres of furnace oil polluting the river Meghna; not mitigated even after 80 hours (Dhaka Tribune, 28 Dec 2022)	Pollution mitigation without spillage tracing is challenging.
Source: National Newspapers [Online]	

SAR and HADR. Every year, casualties at sea are high (Statistics of SAR in Table 6). The Department of Shipping (DoS) is responsible for SAR in the BoB with meagre resources (Iqbal, 2019), for which BN established Maritime Rescue Coordination Centre (MRCC) and Maritime Rescue Sub-Centre (MRSC) (AFD Website). The absence of AIS for detecting immediate distress location and information sharing delays the SAR. Department of Fisheries (DoF) has planned to install AIS in artisan boats, but without integrating it with the COP of MRCC, the purpose may not be optimally served, as opined by Commander MRSC (KII, Azim).

Table 6: *Statistics of SAR in the BoB*				
Year	BN		BCG	
	Rescued (Alive)	Recovered (Dead)	Rescued (Alive)	Recovered (Dead)
2020	104	29	231	59
2021	23	47	533	80
2022	36	28	76	98
2023	89	16	557	54
2024	00	04	47	10
Total	252	124	1444	301
Source: BN and BCG Headquarters 2024				

Maritime Crime and Terrorism. Real-time vigilance is difficult at sea than on land. In Bangladesh, many fishermen had been hostages, attacked, or even killed offshore; nearly 411 fishermen were killed and 1000 grievously injured between 2010-2014 in Cox's Bazar (Saara, 2024). BN fleet Commander, responsible for deploying ships at sea, opines that unless the maritime information from various agencies is integrated and instantly shared, it would be challenging to combat maritime crimes (KII, BN Fleet Commander).

Drug Trafficking. Yaba and Methamphetamine smuggling from Myanmar through coastal waters is alarming. Former Ambassador Shameem Ahsan expressed his anxiety on the proximity of the Golden Crescent and Golden Triangle, funnelling drugs into South Asia (NDC Maritime Seminar, 2024). "Almost 95% Yaba from Myanmar comes by the river Naaf. In 2023 alone 14,73,4774 Yaba and 142,95 kilo Crystal Meth alone were apprehended based on human intelligence (HUMINT) not technological surveillance" (SME, Sector Commander Border Guard).

Protection of SLOC in Evolving Vulnerability. SLOC security is not only a wartime challenge but also a peacetime concern. The government vested BN with the safety of merchant trade in the high seas (MOD Gazette, 1975). Recently, the Somalian and Houthi pirates displayed lethality and vulnerability in the westbound SLOC, for which a regional response is crucial (see Case Study 6). During the piracy of Bangladeshi MV JAHAN and the 33 hostage days of MV ABDULLAH, the SLOC vulnerability in the high sea and Bangladesh's absolute dependency on regional IFCs were evident (bdnews24.com).

Case Study 6-Evolving Vulnerabilities along SLOCs

Evolving Piracy & Terrorism in High Seas (Red Sea, Gulf of Aden, West IO)

Trade Implications: Disruption in SLOC, spike in freight charges, shrinking trade.

Weaponry & Attack Pattern: Somalian piracy onboard Bangladeshi MV Abdullah 600 miles East of Somalia for 33 days. Before that MV Jahan Moni was hijacked. Bangladesh was dependent on regional response. Houthis carried out 43 subsequent armed attacks and 22 missile strikes, sank one UK Ship Rubymar, and also launched ballistic missiles at USS Dwight Eisenhower (US Carrier)

Regional Response: UNSCR 2722/2024 accredited European Naval Force (EUNAVFOR) Operation ASPIDES. India launched Operation Prosperity Guardian.

Role of IFC: Regional Maritime IFC Madagascar (RMIFC), IFC-IOR, IFCs of UKMTO and EUNAVFOR are utilizing Satellite cloud apps, Electronic Intelligence (ELINT), Signal Intelligence (SIGINT), and Network Centric C5ISR (Pandit, 2024).

Lessons for Bangladesh: The Ministry of Defence mandates BN to protect merchant trade in the high seas. It demands real-time anomaly detection and regional information sharing on evolving vulnerabilities. Bangladesh needs its own IFC to share and cooperate with regional IFCs.

Source: (Landale & Gardner, 2024, BBC), (Scarr et al, 2024), (albawaba, 2024), MOD Gazette 1975.

MDA-NEED ANALYSIS FOR BANGLADESH

Securing Trade Dependency. A conducive SLOC and MD are prerequisites for Bangladesh's trade, economy, and security as it aims for 9.9% GDP growth by 2041. Nearly 3000 foreign ships visit Bangladesh's ports yearly, and the projected freight value will be 435 billion USD in the next ten years (Alam, 2021). These offshore economic ventures require MDA with proactive maritime vigilance in Bangladesh's vast MD.

Developing BE. Bangladesh was chosen as a pilot country for BE development by UN Sustainable Development Goal (SDG) - 14 in 2014, which the former Principal SDG Coordinator emphasised, saying, "SDG requires inter-agency monitoring of Marine Protected Areas (MPA) and Delta Plan (Azad, NDC Lecture 2024). BE implications have explicit environmental, safety, and security requirements against maritime crimes, armed robbery, etc. (Iqbal & Kutubuddin, 2020).

Monitoring Coastal Security. Bangladesh's coast meets Myanmar and Indian waters. The former President of the IORA[1] Business Forum aptly commented,

[1]*Indian Ocean Rim Association*

"Transboundary NTS threats due to closed littoral proximity can pose challenges to economic, maritime, and national security" (Fahim, 2024). The porous coastal feature is also susceptible to IUU, smuggling, maritime crimes, and terrorism. As such, "traditional monitoring to combat NTS will require real-time detection, sharing, and a central regulatory framework" (KII, DG BCG). Additionally, for seamless vigilance, "coastal radar chain and 'crowd-sourcing' apps[2] would be essential for Bangladesh" (KII, ACNS Materiel).

Regulating Shipping and Fishing. Nearly 16,078 registered ships, tankers, containers, passenger ferries, and other vessels operate in the coastal waters and adjacent seas (DOS Statistics, 2023). According to the Chattogram Marine Fisheries Office, besides the 12,190 registered artisan boats, the unregistered 32,896 mechanised boats are VUCA to MDA (The Business Standard, 2023). Survey finds 77% of such coastal boats have no AIS, remaining 'unknown' to coastal vigilance.

Seeking Geostrategic Balance. IO is the 'centre stage' of the world with two central enclosed bays-the BoB and Arabian Sea; one leads through Andaman choke points and the other through the Gulf (Kaplan, 2010). Emphasising the significance of the BoB in IOR, the Japanese Ambassador Iwama Kiminori commented, "Bangladesh's Indo-Pacific outlook should focus more on technological vigilance to ensure maritime security" (Keynote Speech NDC, 2024). SAARC, BIMSTEC, IORA, IPMDA, QUAD, BRI, and WSA have the scope of regional maritime information sharing, but the geostrategic balance is vital. However, "amidst the contesting geostrategic canvas, Bangladesh needs a pragmatic policy to participate in regional initiatives to meet its interests" (Khan, 2024).

MDA IN POLICY AND LEGAL ENVIRONMENT

Constitutional Obligation. Bangladesh's Constitution mandates the protection of the MD. Accordingly, the maritime ministries regulate through sectoral policies without any central regulating body (Iqbal, 2019). Article 143 (1) and (2) of the Constitution specifies "all minerals and things of value underlying the ocean within the territorial waters, or ocean over the continental shelf, territorial waters and continental shelf as the property of the Republic" and it requires safeguard. This is a colossal responsibility, as safeguarding is related to the capacity.

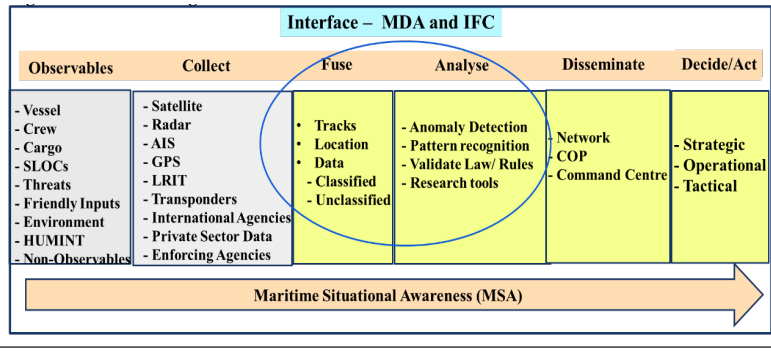
[2] *Sea-watch (Crowd sourcing apps) enables Filipino fishermen to report suspicious incident/crime from sea using mobile via Satellite relay (Brewster, 2023).*

Territorial Waters and Maritime Zones Act, 1974 (Amendment 2021). Maritime Zones Act has specified directives relating to sovereignty, territorial integrity, threats to maritime installations (Section 15), dumping, pollution, noxious/nuclear discharge (Section 5, 8, 17), rescue of shipwrecked vessel and personnel up to high seas (Section 4, 10) and suppression of piracy, armed robbery, terrorism, illegal fishing (Section 9). It also advised Ocean Governance, BE, and regional cooperation (Section 7). It entrusted BN and BCG to board, investigate, and arrest (Sections 11 and 28) and keep electronic evidentiary proofs (Section 29) for legal proceedings. HADR and military surveys have also been authorised in Sections 7 (G) and 7 (H).

IFC IN BANGLADESH'S MDA FRAMEWORK

MDA and IFC Interface. Professor Goward's MDA Model 2006 (Jacinevicius & Petrauskas, 2008) simplifies the interface between MDA and IFC. It illustrates that information comes from different observables, vessels, SLOCs, threats, and 'non-observables' like HUMINT. IFC gathers information using Satellites, Radar, AIS, LRIT, and other sensors and platforms. A Geographic Information System (GIS) fuses multiple data and information. Fusion is complex because the correlation is not standardised (Yanze, 2015). However, the IFC collects, evaluates, correlates, and classifies threats using AI software algorithm (Soldi, 2021). The networked COP is shared in real-time with decision-making layers for response (Figure 3).

Figure 3: *IFC Working Model-MDA and IFC Interface*



Source: Goward, 2006 (at: https://ndia.dtic.mil/wpcontent/uploads/2006/hls/goward.pdf)

BENEFITS OF IFC FOR BANGLADESH'S MDA

Real-Time Vigilance. Satellite cloud apps can monitor massive maritime traffic, identify anomalies, and generate automated responses for security enforcers.

SAR and HADR. IFC can pinpoint distress from AIS, Emergency Position Indicating Beacon (EPIRB), Distress Alert Transponder (DAT), to rescue (FGD).

Anomaly Tracking. During the SME interview, the maritime law specialist working in BN stated that maritime crime would require legal follow-up where digital anomaly tracking by IFC is pivotal, as 'electronic evidence of maritime crime can be presented in the International Court' (SME, Maritime Law Specialist, BN).

Dumping and Pollution Control. Dumping and pollution cannot always be detected by physical surveillance. "Detection of toxic dumping, oil spill, deliberate/ accidental pollution through Cloud apps like Hawkeye, NORBAT, Sea Vision is possible" (SME, Director Hawkeye360).

Proactive Deployment. AI correlates patterns and behavioral analysis of suspicious vessel movements and anomalies for proactive and cost-effective surveillance deployment, avoiding duplication of operational efforts.

Coastal Security Layer. The IFC strengthens layered coastal security, predicting early suspicious movement. Taking the lesson of the Mumbai terror attack in 2008, where terrorists had maritime access, "Indian IFC is integrating their large fishing community by registering AIS/DAT/mobile network to strengthen coastal security" (SME, BN Observer in IFC-IOR).

INFORMATION FUSION-CHALLENGES AND OPPORTUNITIES IN BANGLADESH

Challenges in Inter-agency Integration. Inter-agency integration of information is challenging. The Chairman BIWTA, responsible for internal water transportation in Bangladesh, opines that no single maritime agency can have all the information. However, each has something to share (KII, Chairman BIWTA). On the contrary, not every agency requires all but relevant information. However, "we need to decide what information we want in IFC and with whom to share" (KII, COMFLOT West). Fusing inter-agency information on a central GIS and

sharing it with concerned agencies requires a protocol. However, the scope of bridging information of various zones, the challenges involved, and probable inputs are shown below (Table 7).

Table 7: *Bridging Information for COP in Bangladesh*

Zone	NTS Focus	Common Challenges	Agency Inputs
Inshore	IUU fishing, maritime crime, SAR, HADR	• High vessel density • Absence of real-time detection • Difficulties of monitoring/ tracking • Overlapping sectoral jurisdiction • Absence of Inter-ministerial/Inter-agency integration	• BN with sensor inputs (all zones) • BCG with sensor inputs (coastal) • River Police with criminal data (inshore waters) • Ports with VTMIS (up to CZ) • DoS on traffic information (BOB) • DoF on fishing community information (coastal) • BIWTA on vessel movements (inshore)
Territorial Sea & Contiguous Zone	Armed robbery, smuggling, pollution, maritime crime, marine accidents, illegal migration		
Exclusive Economic Zone	IUU, piracy, arms &drug smuggling, illegal migration, marine accident, dumping, SAR		
High Seas	Piracy, dumping, illegal migration, marine accidents		

Source: Researcher's Findings from KII

Opportunities from Existing Practices and Initiatives. Bangladesh has nearly 25 maritime ministries, security agencies, regulatory organs, seaports, and ancillary organisations. Some of the ongoing IT-related initiatives/projects are:

DoF. DoF has taken up the Sustainable Coastal and Marine Fisheries Project (SCMFP) to monitor fisheries, including IUU activities, and equip AIS in artisan boats (SME, Project Officer SCMFP). However, a comprehensive response must integrate BN and BCG.

DoS. With Korean technical support, DoS has launched the Establishment of GMDSS and Integrated Maritime Navigation System (EGIMNS) to track AIS and LRIT in the BoB. It can get distress location from Air Traffic Control (ATC) Dhaka via ATC Delhi through COSPAS-SARSAT.[3] However, EGIMNS is not yet integrated with the response agencies.

BIWTA. Ongoing BIWTA's 'Riverine Transport Project-1', financed by the World Bank, will monitor inshore vessels in 'Chattogram-Dhaka-Ashuganj'. However, the Chairman BIWTA agrees that inshore information must be shared with BN and BCG to handle marine casualties, SAR, and HADR" (KII, Chairman BIWTA).

[3]*COSPAS-SARSAT-Joint Russian-American programme having Observation and Geostationary Satellites. India incorporated COSPAS-SARSAT with IFC-IOR.*

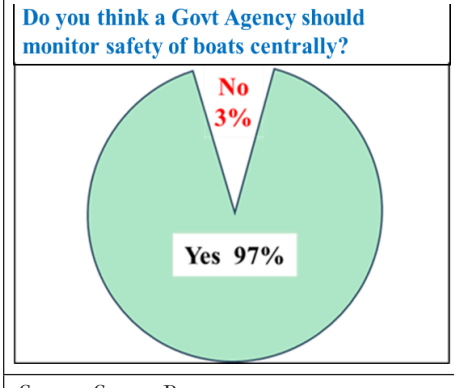
Ports. Bangladeshi seaports have a Vessel Traffic Management Information System (VTMIS) to monitor live traffic up to the fiscal limit of the port (Rahman, S., 2016). "VTMIS can trigger early warning for coastal and harbour security, if integrated" (KII, Chairman Mongla Port).

BN and BCG. BN and BCG deploy ships, patrol aircraft, and helicopters for vigilance. Incorporating subscribed apps like IORIS, SENTINEL, C-MAP, and others is essential for real-time vigilance. Bangladesh recently signed the CRIMARIO.[4] project to use IORIS for 'white-shipping'[5] monitoring (Director Naval Operations during FGD). More such apps will ease surveillance time lag as Bangladesh has no observation Satellite. Besides, the Assistant Chief of Naval Staff emphasised on coastal radar network, Drone, UAV, UUV, and cyber directorate for action-centric MDA (KII, ACNS Operations).

SURVEY FINDINGS

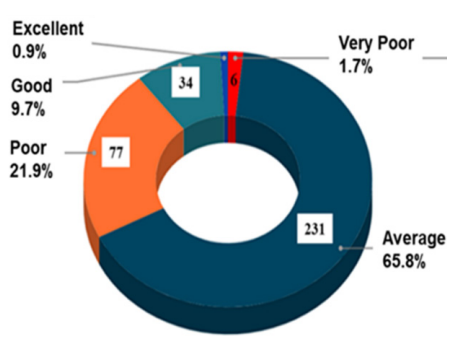
In a survey, 117 of the 171 boats were found to have a Communication Set, but the rest 54 respondents did not. Alarmingly, 131 (77%) without AIS/Distress equipment are exposed to the risk of life at sea. (46 out of 171) cannot inform the casualty to response authorities. More than 50% complain about the delay in SAR. Finally, 97% of boatmen opined that a central agency must constantly monitor boats at sea (Figure 4).

Figure 4: *Need of Central Agency*



Source: Survey-Boatmen

Figure 5: *Rate current status of Bangladesh's MDA*

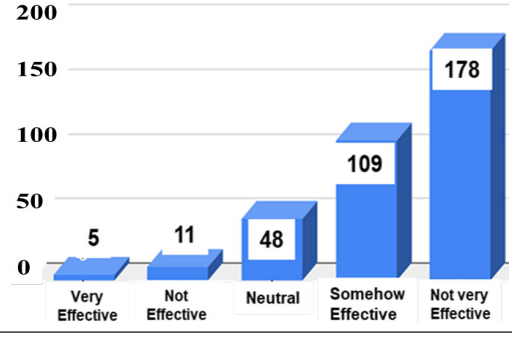


Source: Survey-Seagoing Officers

[4] *CRIMARIO-Critical Maritime Routes Indo-Pacific.*
[5] *'White-shipping' - Non-military commercial shipping*

In another survey of 352 seagoing BN and BCG officers, 89.4% identified the present MDA as average or below (Figure 5) because in 50% of cases, anomalies remain undetected/unreported due to inefficient information sharing. 84.6% think Bangladesh's inter-agency information sharing is not/not very effective (Figure 6).

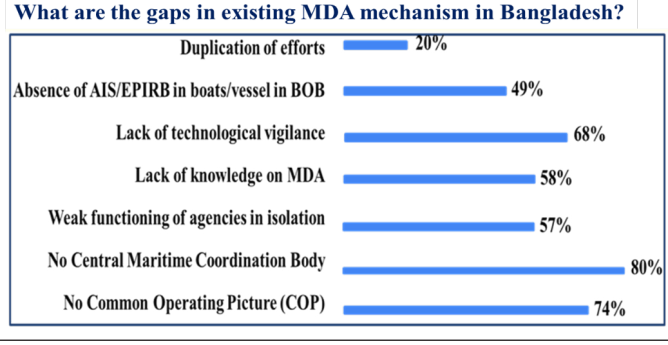
Figure 6: *Effectiveness of present Inter-agency Info Sharing*



Source: Survey-Seagoing Officers

During the survey, the absence of a COP, central coordinating body, and meagre technological vigilance was recognized as gaps in the MDA mechanism (Figure 7).

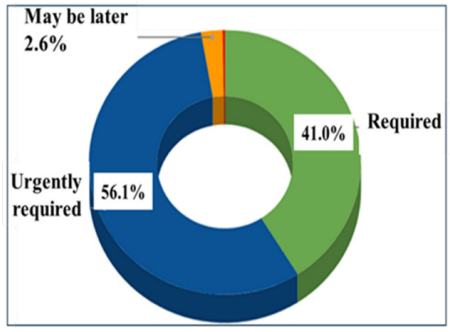
Figure 7: *Gaps of Existing MDA*



Source: Survey-Seagoing Officers

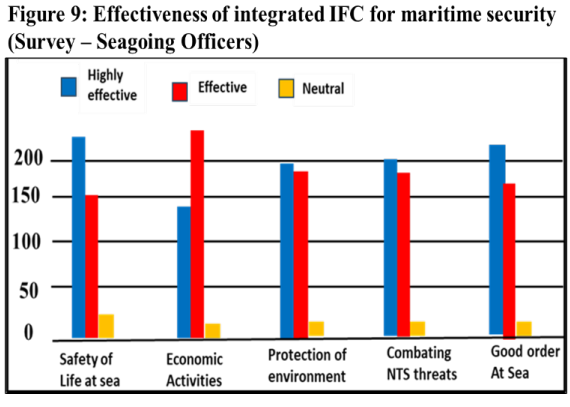
Rationally, 93.7% demand integrated COP for gapless vigilance, 85.8% feel physical patrolling needs technological augmentation, and 97.1% endorse IFC as urgently required for maritime safety and security (Figure 8). Most respondents think COP will be effective/highly effective for protecting lives, the economy, and the environment, combating NTS, and maintaining good order (Figure 9). The need for IFC under a national framework is evident from the survey.

Figure 8: *Need of Integrated IFC in Bangladesh*



Source: Survey-Seagoing Officers

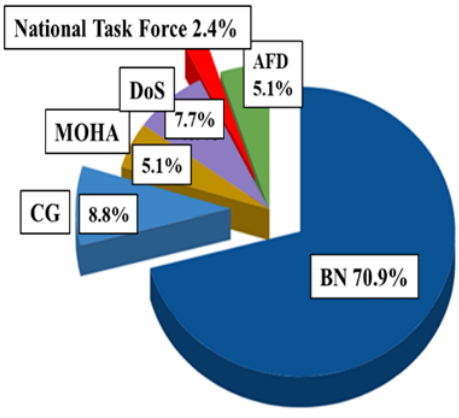
Figure 9: *Effectiveness of integrated IFC for maritime security*



Source: Survey-Seagoing Officers

There were mixed opinions regarding the lead agency. Few broad frameworks: National Maritime Information Fusion Centre (NMIFC) and National Maritime Security Centre (NMSC) at the functional level, and National Maritime Domain Awareness Authority (NMDA) at the apex could be sorted out from the open-ended survey (Table 8). During KII, some referred examples of other littorals where NMIFC deals with White Shipping and NTS threat information could be led by BCG, and NMSC for confidential and cyber networking should be led by BN. However, in general, 70.9% opined that BN should lead the integrated IFC for expertise and its security nature (Figure 10). At the apex, NMDA should be advised by the appropriate Cabinet under the Prime Minister's Office (PMO).

Figure 10: *Lead Agency of NMIFC*



Source: Survey-Seagoing BN & BCG Officers

Table 8: *Proposals of IFC vis-à-vis MDA Authority*

National Maritime Council (NMC) under PMO	National Maritime Division (NMD) under the MOFA/MOHA/ Shipping Ministry	NMDA under PMO
National Task Force (NTF)	Separate Maritime Ministry	NMSC under BN
Integrated NMIFC in Naval HQ, Chattogram, and Mongla under BN	NMIFC under DoS	National Maritime Security Division under AFD

- NMIFC-70.9% opined that BN should lead NMIFC.
- NMSC-For confidential/Cyber networking under BN.
- NMDA-97.7% suggested National MDA Authority under PMO.

Source: Survey-Seagoing BN & BCG Officers

WAY FORWARD

Model Study-Neighbouring Countries' IFC

South East Asian IFC (Model Study 1). The Singapore, The IFC, Maritime Crisis Centre (SMCC), and Multinational Operations & Exercise Centre (MOEC) are '3 in 1 block' (Bueger, 2015). Singapore uses OASIS, SMART, and ReMIX software for information analysis and sharing with stakeholders. Filipino IFC (MRIC) is connected with Singapore IFC and USINDOPACOM, and Indonesian IFC (IMIC) is associated with Singapore portal information (see Model Study 1).

Model Study 1: *IFCs in SE Asia (Singapore, Philippines, Indonesia)*

IFCs in SE Asia (Singapore, Philippines, Indonesia)

Singapore : Navy is the lead agency.

- IFC, Singapore, Maritime Crisis Centre (SMCC), and Multinational Operations & Exercise Centre (MOEC) – **3 in 1 Block.**
- IFC for international sharing, SMCC for state agencies and MOEC for multilateral SAR.
- Uses Open & Analyzed Shipping Info System (**OASIS**) for info gathering, Sense-Making Analysis & Research Tool (**SMART**) to detect anomalies and Regional Maritime Info Exchange (**ReMIX**) for sharing with ReCAAP, IFC of India, Japan, EU & AU countries, Malacca Straits Patrol Info System (MSP-IS) with ASEAN littorals.

(Source: Bueger, 2015)

Philippines : **Navy is the lead agency**.

- Maritime Research Information Center (MRIC) uses U.S. Sea Vision & Marine Traffic.
- MRIC interfaced with Singapore, USINDOPACOM and coastal radars via Tactical Data Link (TDL). Fishermen uses 'crowd sourcing' apps for live sharing info from the sea via Satellites mobile network. **(Source: Cabigon, 2020, pp32-45)**

Indonesia : **Coast Guard (Bakamla) lead agency.**

- Indonesian Maritime Information Centre (IMIC).
- IMIC Portal information sharing is not real-time and is not yet fully satisfactory.
- Indonesian IMIC depends on IFC Singapore for multilateral maritime info-sharing.

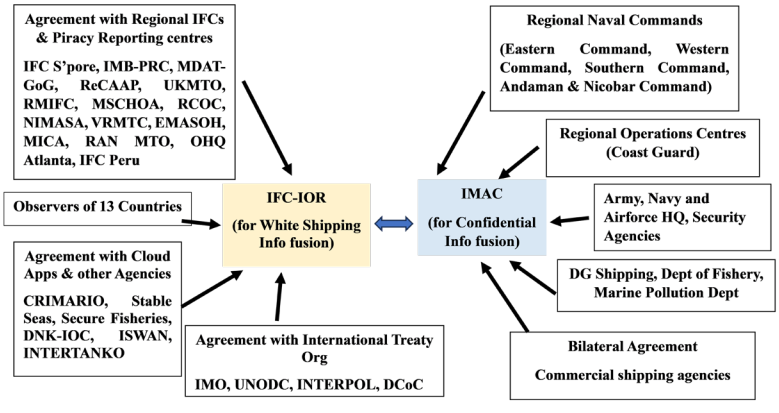
(Source: Setyawati et al, 2021)

Source: Secondary sources [Online], SME interview of Attaches and IFC Observers

Indian IFC (Model Study 2). Navy-led Indian Maritime Analysis Centre (IMAC) integrates 51 coastal stations, naval Signal and Electronic Intelligence (SIGINT and ELINT), and Satellite apps. Later, IFC-IOR was established in 2018 in the same IMAC building for sharing White Shipping information with other regional IFCs, IMO, Interpol, and various treaty-bound organizations (see Model Study). "IFC-IOR and IMAC are interfaced but channeled separately for white-shipping and national security monitoring, respectively" (SME, Observer IFC-IOR). It uses NISHAR (Network for Information Sharing) software. Besides,

"India has revamped its traditional maritime governance by integrating 22 maritime ministries, agencies, and establishing a National Maritime Coordinator (NMC) for harmonizing the information protocol between IMAC and IFC-IOR" (SME, Shankar).

Model Study 2: *IMAC and IFC-IOR*

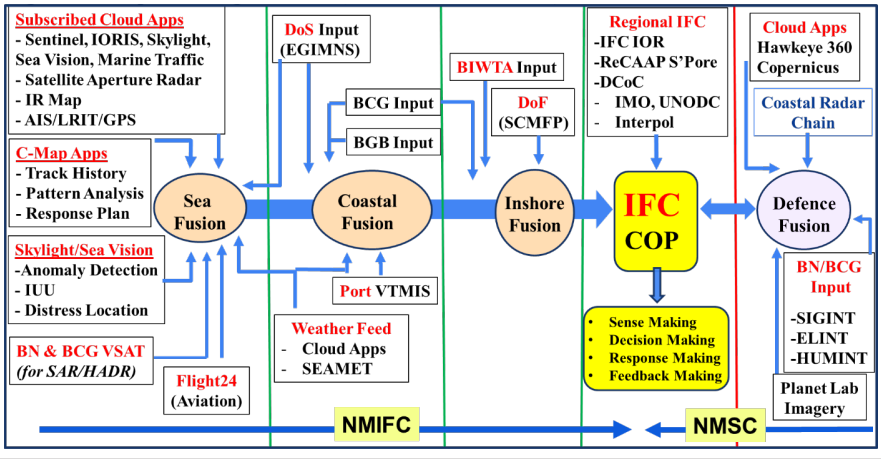


Source: Researcher's Construct based on secondary sources [Online] and SME interview

PROPOSED IFC FRAMEWORK FOR BANGLADESH

Taking the perceptions and ideas of other regional IFCs into account, Bangladesh can have an IFC with tailored options. It could have two blocks: the NMIFC for national and regional sharing of white-shipping information and the NMSC for sharing amongst national security agencies. After FGD, an integrated IFC for Bangladesh with Sea, Coastal, and Inshore segments integrated into the central COP is proposed (Figure 11). The Defence segment NMSC can be stand-alone but interfaced with NMIFC, like the Indian IMAC and Singaporean SMCC.

Figure 11: *Proposed Integrated IFC Framework for Bangladesh*



Source: Researcher's Construct

Sea Fusion. The Sea Fusion segment can cover the BoB and the high seas of AOI. "Cloud apps like IORIS, Skylight, Sentinel, Sea Vision on C-Map are experimentally fused in BN IFC Pilot project" (KII, COMFLOT WEST). With the signing of the CRIMARIO project, apps like IORIS, Skylight, and Sentinel can be used (FGD). Using ENIGMS, the distress information, transmitted through Digital Service Calling (DSC) via coastal stations and Very Small Aperture (VSAT) used by BN/BCG may be integrated with MRSC for SAR (SME, EGIMNS Project Officer).

Coastal Fusion. "Port VTMIS can augment COP" (SME, VSAT Project Officer). "SCMFP of DOF can monitor AIS and GPS of artisan and IUU boats, which can be integrated with IFC by mobile digital selective calling (DSC)" (SME, SCMFP Project Officer). However, integrating the maritime community is crucial as nearly 60k artisan boats depend on the security response by maritime forces. HUMINT with a criminal database is also essential for coastal intelligence that needs to be connected.

Inshore Fusion. "Ongoing monitoring potential of the BIWTA project using GPS and AIS can offer a live inshore picture" (KII Chairman BIWTA). SPARSO and BMD can add weather data as a 'stand-alone' system in IFC. As maritime weather warning is crucial, establishing the Sea Meteorological (SEAMET) Centre with NMIFC may be considered in the future.

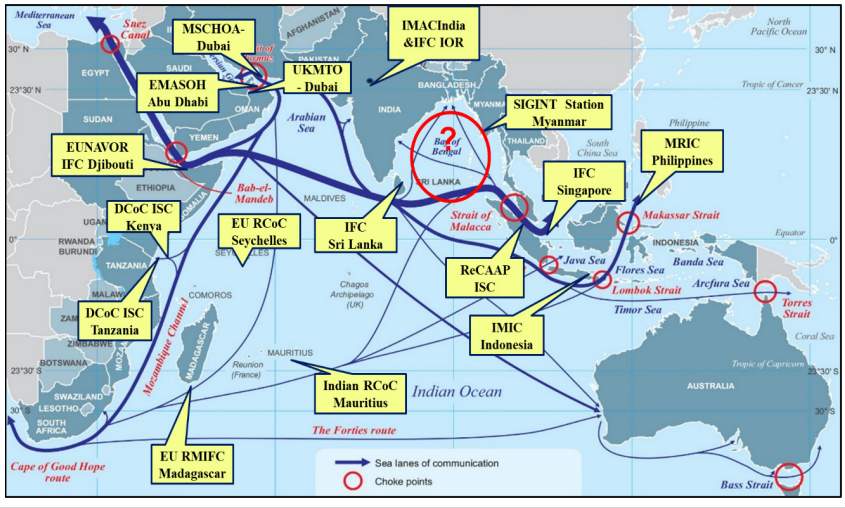
Defence Fusion. BN and BCG can use SIGINT and ELINT for constabulary vigilance (FGD). Hawkeye360 can make Radio Frequency triangulation of suspicious vessels (SME, Director Hawkeye). Planet Lab can offer sub-daily pictures of the coasts (FGD). Besides, cloud apps like Unseen Lab, Copernicus, and Airbus have defence intelligence options. However, these apps should be stand-alone in NMSC for confidential use by the maritime forces and intelligence agencies. BGB border vigilance can also facilitate monitoring illegal migration, drug/arms cartels in coastal areas.

Futuristic Thoughts. Deep-ocean Assessment & Reporting of Tsunami (DART), coastal radar chain, UAV, UUV, Satellite with Synthetic Radar, Visible IR Imaging Radiometer Suite (VIIRS) may be considered (FGD). Some local software experts affirm, "developing indigenous fusion and sharing software locally is possible, although the hardware dependency cannot be ignored" (SME, Software Engineer, Dhaka). Ministries may fund R&D for self-reliance. Bangladesh Ocean Research Institute (BORI), Bangladesh Institute for Maritime Research & Development (BIMRAD), Bangladesh Maritime University, and Bangladesh Institute for International Studies (BIIS) may be incorporated to formulate MDA policies. Finally, the boatmen community of the coastal belt of Bangladesh should come under a registered network gradually.

REGIONAL INFORMATION SHARING

Safety of merchant trade in SLOC, choke points, and piracy-prone areas cannot be ensured by any littoral state singly. The DG BSC concurs that information sharing by other regional IFCs during MV ABDULLAH piracy was appreciable (KII, DG BSC). A bilateral/ multilateral MoU/agreement is needed for information sharing with other IFCs. Regional naval cooperation, like the Malacca patrol of Southeast Asia, European Union Naval Force (EUNAVFOR) operations, and Indian Ocean Naval Symposium (IONS), can ensure SLOC safety in the high seas through cooperative engagement utilizing IFCs. Littorals need to maximize regional cooperation. The research also identifies the significant IFCs, Maritime Security Centres (MSC), and Reporting Coordination of Operations Centers (RCOC) in Bangladesh's AOI (Figure 12). Although QUAD versus BRI friction in IOR is unavoidable, Bangladesh's IFC may be tailored to suit its foreign policy, striking the regional balance for economic prosperity, free SLOC, and the global commons (KII, ACNS Operations).

Figure 12: *Regional IFCs/ MSCs/ RCOCs in SLOCs of Bangladesh's AOI*

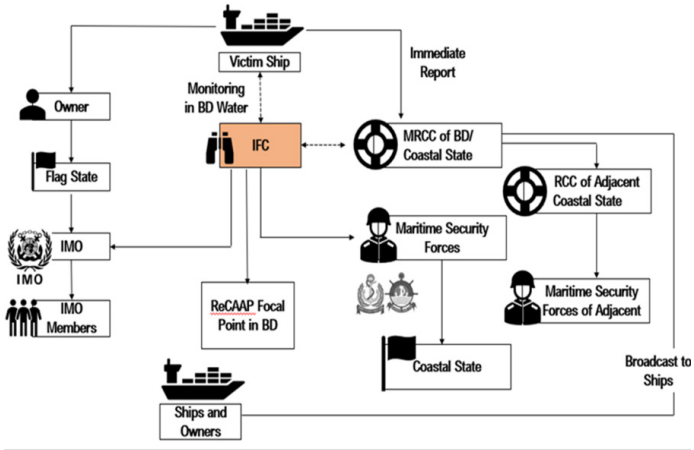


Source: Secondary sources [Online] and SME interview of Observer IFC IOR

INTEROPERABILITY - CONCEPT OF COMMERCIAL OPERATIONS (CONCOPS)

CONCOPS is essential for the interoperability, communication, operational, and legal procedures. The DG BCG candidly suggests, "CONCOPS may include 'victim-agency-military' interface to meet multi-agency protocols in adherence to domestic and international laws" (KII, DG BCG). NMIFC may link the flag state, vessel owner, regional IFCs, IMO, and treaty organisations, and host state response forces by CONCOPS depicted below (Figure 13). In crisp, IFC can act as the link to regulate and foster the 'victim-agency-military' interface by detecting the anomalies at sea, sharing the information with concerned regional IFCs, the flag state, the owner agency as appropriate, and directing responsible maritime forces to act accordingly.

Figure 13: *CONCOPS*



Source: Researcher's Construct

MDA AND IFC - PROPOSED FUNCTIONAL AND APEX FRAMEWORK

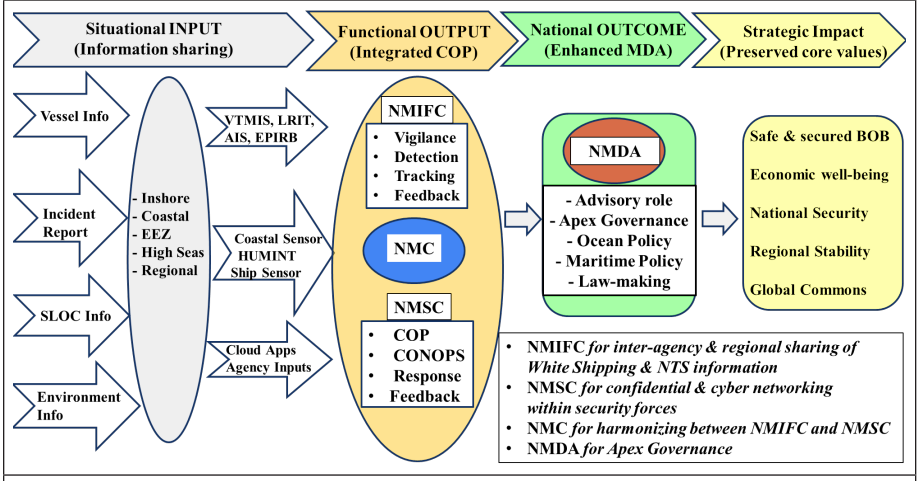
'Ends Justifying Means'. While translating national interests into inter-ministerial strategies, the state has to synergise the national responsibilities (Gemma, 2020). In Bangladesh, the means of the MDA mechanism should meet the strategic ends. The maritime ministries through NMIFC and NMSC may integrate different maritime agencies to develop the COP. There has to be a regulating and functional layer of mechanisms to monitor, coordinate, and direct the IFC activities. At the apex under PMO, the National Maritime Domain Awareness Authority (NMDA) may govern the maritime ministries and liaise with international instruments. However, a separate maritime ministry is yet to earn currency in Bangladesh. The research did not venture into what hurdles it but it could sense that 'who leads the integrated maritime authority' is a dilemma. The bureaucratic procedures for real-time inter-agency information sharing may streamline jurisdictional responsibilities and protocols that trigger superfluous prohibitions. Genuinely, "collective security entails integration and Bangladesh may revamp its MDA as so-called 'analogous' information sharing will not suit the 4IR era" (KII, DG DoS). So, Bangladesh's MDA vis-à-vis IFC mechanism may ponder an integrated functional and national framework to meet the strategic ends. (Figure 14).

The Functional Mechanism. In India, IMAC and IFC-IOR monitor national security and white-shipping information separately but are integrated, led by the Navy at the functional level (see Model study 2). The same pattern exists in Singapore for inter-agency, multi-national, and regional information sharing (see Model Study 1 - Singaporean IFC '3 in 1 block'). Bangladesh can integrate NMIFC and NMSC in the '2 in 1 block'. NMIFC can be led by BCG under the Shipping Ministry and manned by concerned agencies. BN may lead NMSC for sharing within the security agencies, viz AFD, BCG, RAB, narcotics, and intelligence agencies. It will demand an appropriate information sharing and security protocol in this regard. However, "data secrecy in the Satellite era should not be enigmatic to information sharing, instead protect cyber breaches" (FGD).

The Apex Authority. In 2006, the Government established a National Maritime Council in Bangladesh, but its composition was neither full-fledged nor functionalised. This research proposes NMDA for future study. However, the Cabinet Secretary, Chief of Navy, AFD, Foreign Affairs, Home Affairs, Shipping, and concerned ministries can form the NMDA. Meaningfully, it is crucial for Bangladesh as "IMSAS[6] 2015 reported the absence of a national regulatory maritime governance in Bangladesh. It's non-compliance by next audit of 2025 may downgrade Bangladesh's IMO category detrimental to our trade" (KII, Chief Examiner DoS). As such, NMDA can be a solution to it. However, for that, "we need an approved Ocean and Maritime Policy upon which the roadmap to NMDA and its functionality will be shaped up" (KII, Secretary MOFA, Maritime Affairs Unit). Meanwhile, a designated National Maritime Coordinator (NMC) with professional expertise may harmonise the inter-ministerial integration of NMIFC, NMSC, and the macro-management of MDA.

[6]*IMSAS - IMO Member State Audit Scheme. Presently, Bangladesh is in IMO Category C out of 175 countries.*

Figure 14: *Proposed MDA and IFC for Bangladesh-Mechanism and Governance ('Ends Justifying Means')*



Source: Researcher's Construct

RECOMMENDATIONS

The research recommends the followings:

- Inter-ministerial evaluation of the MDA framework, information sharing protocol of various maritime agencies, and funding to establish the NMIFC and NMSC with appropriate lead agencies may be considered.

- The Government may develop a national ICT plan to boost technological capabilities in the maritime sector and build software for information fusion, incorporating cloud apps, inputs from various agencies and sensors.

- The Government may consider strengthening partnerships for regional information sharing with international organizations, suitable cloud apps companies, and regional IFCs of its Area of Interest (AOI) along the SLOCs.

- The Government may consider installing a coastal radar chain and equipping BN and BCG with UAV, UUV, and MPAs with electronic surveillance and data linking facilities.

- At the inter-ministerial level, streamlining jurisdictional charters of information sharing responsibility, information security protocol, and

protection against cyber threats, hacking, and illegitimate information sharing may be devised.

- The Department of Shipping and Fisheries may jointly register the boatmen and fishing communities in NMIFC and gradually equip AIS/EPIRB in seagoing boats.
- The Department of Shipping may develop the National Maritime Data Centre through NMIFC. The incorporation of BIMRAD, BORI, BIIS, and Maritime University in the doctrinal formulation of MDA may be considered.
- BN and BCG may consider developing a Cyber Directorate at their headquarters and appointing Observers in suitable regional IFCs.

Future Research on:

- Developing a National Ocean and Maritime Policy to enhance Bangladesh's MDA to implement the framework of NMDA as the Apex Maritime Governing Body may be considered.
- Setting the necessary criteria for a future Bangladeshi Observation Satellite with Synthetic Radar, Visible IR Imaging Radiometer Suite (VIIRS), SIGINT, and ELINT option may be considered.
- Establishing the SEAMET centre with Deep-Ocean Assessment & Reporting of Tsunami (DART) may be considered.

CONCLUSION

Real-time vigilance and information sharing of 'what is happening' in the MD is crucial for maritime safety, security, economy, and the marine environment. Accordingly, global littorals are now duly focusing on IFC as a part of their action strategy to enhance MDA in the evolving security scenario. IT has facilitated the MDA by fusing huge maritime data for 'action-centric' and timely response. However, Bangladesh falls short in MDA in utilizing such technologies. Its maritime security mainly depends on physical vigilance in the vast MD, where nearly 25 maritime agencies operate in isolation without a COP. Despite the geostrategic and maritime significance, Bangladesh lacks an integrated approach to combat the NTS threats. Bangladesh's MDA amidst the Indo-Pacific contest remains dependent on other regional information regimes. Bangladesh needs

an IFC of its own as the BoB connects the maritime super highway of IO. As the Constitution obligates, it is essential to safeguard the safety of lives and properties in Bangladesh's MD. Considering the present MDA status and growing NTS challenges, this research has judiciously established the requirement and feasibility of IFC in Bangladesh. The research survey depicts the needs assessment. The proposed IFC will serve as a central hub for the maritime agencies by networking situational information from various maritime agencies. A 'whole of government' approach and regulatory framework will be required to integrate the existing and ongoing technology initiatives and further incorporate AI, cloud apps, data fusion, and sharing software. Once implemented following a roadmap of 5 years, Bangladesh's MDA through NMIFC and NMSC is expected to contribute positive functional output (integrated COP), envisaged national outcome (enhanced MDA), and strategic impact (preserved core values) in the national and regional maritime canvas.

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