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MESSAGE FROM THE CHIEF OF NAVAL STAFF

‘Bismillahir Rahmanir Rahim’

I am delighted to see the 'Navy Journal 2025' coming to light with its 10th edition. This endeavour will certainly appease the thoughtful and creative minds on various contemporary issues related with advance technology, future warfare, leadership and prospects in maritime domain. Certainly, the glorious depiction of the journey and development of our beloved Navy is yearning to be unveiled through this publication. I wish, the esteemed readers' contentment will testify the contributors' efforts.

Navy Journal, a testimony of intellectual reflection of naval personnel, is contributing towards enhancing knowledge of BN personnel. Despite being under hectic routine with official works, a number of intelligent officers made humble efforts in accommodating their synthesised ideas here. I believe this volume will signal as a beacon not only to guide the young members for their flourishing as 'cognitive warriors', but also will enable them to utilise the gained experience as a treasure house of knowledge.

With technological advancement and trained manpower, the operational scopes of BN has increased manifold. Starting from the core duty to protect the sovereignty, BN is relentlessly working to uplift the national economy, infrastructural development, establishing good governance, and supporting civil administration during the time of need. In consensus with the foreign policy, BN is actively instating harmony with the regional and international communities operating and administering vast oceans of the world. Another sacred task of navy is to keep the Sea Lines of Communication (SLOC) unhindered to support national trade and commerce. BN is performing this noble and complex responsibility uninterruptedly in the Bay of Bengal.

This professional journal of BN encompasses writings of our committed researchers to unveil their professional insight and excellence. I firmly believe that "Navy Journal 2025" is going to attract the inquisitive minds of its readers about how Bangladesh Navy is advancing to cope up with the contemporary traditional and non-traditional challenges. I wish to felicitate all concerned personnel for their relentless contributions behind this journal.

May Allah SWT shower His kindest blessings upon Bangladesh Navy and her crew.

M NAZMUL HASSAN

Admiral

Chief of Naval Staff

EDITORIAL

The publication of Navy Journal 2025 heralds the literary pursuit of naval personnel who dig out their dormant ideas and blend them with the reality of life. The entire gamut of write ups involve intrinsic values of intellectual innovation. I believe the rigors the writers have put up to create a finest product, will be able to satisfy the aspiration of esteemed readers. I hope this publication will help to pave the way for research and development work of readers in general and the young writers in particular.

Laden with the invaluable articles, the journal is expected to entail a lot of intellectual benefit that will enable the readers to extract sublime tranquility where the lucidity in style, simplicity in language and the articulating usage of dictions are concerned. The prolonged experience of professional naval personnel conferred multidimensional issues that will help the next generations to modernize our beloved navy with latest platforms emanated from modern sophisticated technology of the era.

The editors have left no stone unturned to make this journal textually and content wise refined, complete and a presentable one. Despite all of our relentless effort to make the journal error free, it is not unusual to have some unintentional flaws and shortcomings as being printing mistakes in a mammoth professional publication like it. We, the editorial board, hope that our wise and valued readers will consider these flaws and foibles as inadvertent ones out of their gracious gesture. However, we welcome our esteemed readers and feel obliged to accept any constructive criticism for the improvement of the publication with sincere gratitude and admiration.

The editorial board extend their sincerest gratitude to the Chief of Naval staff for gracious guidance and to the Chief Patron Rear Admiral Mohammad Musa, OSP, NPP, rcds, afwc, psc, PhD for his timely guidance and valuable advice for this journal coming into being. We benignly acknowledge the extraneous endeavour of all members of the editorial board for extending their selfless support behind this publication.

CONTENTS

THE EVOLUTION AND INDISPENSABLE ROLE OF IFF TECHNOLOGY IN MODERN WARFARE	01
Rear Admiral Khandakar Akhter Hossain, NUP, ndc, psc, PhD	
COMMANDING GENERATION Z IN DIGITAL AGE : CHALLENGES OF MILITARY LEADERSHIP IN CONTEXT OF BANGLADESH ARMED FORCES	25
Commodore Mirza Ali Akbar Shirazi, (N), OSP, afwc, psc, BN	
INTERNAL ARMED CONFLICT IN MYANMAR : TWO TURNING POINTS	45
Commodore Kutub Uddin Mohammad Amanat Ullah, (G), NUP, afwc, psc, BN	
BANGLADESH FORCE MARINE UNIT : PROMOTING PEACE, STABILITY AND SECURITY IN SOUTH SUDAN UNDER BLUE HELMET	61
Captain Md Zahirul Haque, (C), BCGM, BCGMS, psc, BN	
INTERAGENCIES COOPERATION VIS-À-VIS BANGLADESH'S MARITIME SECURITY OUTLOOK	78
Captain Mehedi Hassan, (C), NUP, psc, BN	
EXPLORING BANGLADESH'S FISHERIES POTENTIAL FOR BLUE TRANSFORMATION : A COMPARATIVE ANALYSIS ON A GLOBAL SCALE AND OPTIONS FOR BANGLADESH NAVY	91
Commander Md Nur Hasan, (E), PCGMS, psc, BN	

CONTENTS

DIGITAL BATTLEGROUND : CHARTING CYBER THREATS IN NAVAL WARFARE 105

Commander Mahbuba Afroze, (L), afwc, psc, BN

SECURING BANGLADESH NAVY IN THE AGE OF CYBER WARFARE : CHALLENGES AND STRATEGIES 124

Commander K M Nazrul Islam, (E), NGP, afwc, psc, BN

CHARTING A COURSE TO PROSPERITY UNLOCKING BANGLADESH BLUE ECONOMY WITH HYDROGRAPHIC DATA 141

Commander Md. Yousuf Ali, (H1), psc, BN

WAVE ENERGY : A PROMISING SOURCE OF RENEWABLE ENERGY AT COASTAL AREA 159

Lieutenant N M Saruar Jahan, (E), BN

THE EVOLUTION AND INDISPENSABLE ROLE OF IFF TECHNOLOGY IN MODERN WARFARE

Rear Admiral Khandakar Akhter Hossain, NUP, ndc, psc, PhD
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Abstract

In modern battlefields, situational awareness is crucial for military forces to make informed decisions and gain a strategic advantage over their adversaries. Identification Friend or Foe (IFF) technology plays a vital role to achieve this objective by allowing friendly forces to differentiate between friend and foe in real time. This article explores the evolution and indispensable role of IFF technology in bolstering national security amidst the challenges of modern and complex warfare. IFF systems have significantly advanced over the years, adapting to the ever-changing battlefield dynamics and the emergence of sophisticated threats. This paper delves into the historical development of IFF technology, from its inception during World War II to its current state, characterized by cutting-edge advancements in sensor technologies, data fusion, and artificial intelligence. The system uses various methods such as radar, transponders, and encryption techniques to identify friendly forces and prevent friendly fire incidents. IFF technology has become increasingly important in modern warfare, where asymmetric and non-linear conflicts are the norm. The use of unmanned aerial vehicles (UAVs) and other unmanned systems has further increased the need for effective IFF systems. The absence or failure of IFF technology can have severe consequences, such as fratricide incidents, misidentification of targets, and loss of valuable resources. The use of IFF technology can help enhance the effectiveness and safety of military operations, minimize the risk of friendly fire incidents, and ultimately contribute to the success of the mission as well as safeguarding the national security. The article examines the key components and operational principles of contemporary IFF systems, emphasizing their ability to accurately identify and differentiate between friendly and hostile entities in real-time, thereby reducing the risk of fratricide and enhancing situational awareness on the battlefield. It highlights the importance of interoperability among military forces and the necessity of standardization in IFF protocols to ensure seamless integration and information sharing among diverse platforms and coalition partners.

Keywords: IFF, Friend or Foe, Fratricide, Interoperability, Indigenous, Warfare.

Introduction

In modern-day context, technological advancement has contributed to increasing ‘the fog of war’. The influx of higher precision weapons and munitions fired from a standoff distance has become the norm of modern warfare. With the advancement of technology and concept of operations, battles have become more complex. Elements of battles and the warfare have also increased proportionally, and thus mistakenly attacking one's own forces has also increased which is known as fratricide. Friendly fire arises from ‘the fog of war’, the confusion inherent in warfare. In such a prevailing scenario, Identification Friend or Foe (IFF) can be considered of utmost importance for winning against an adversary as well as avoiding fratricide. During the Gulf War¹ in 1991, under the circumstances of a lopsided power mismatch, nearly half of the casualties of the multinational forces were caused by self-killing due to the incorrect identification of friend and foe. Similar thing also happened in the ongoing Russia war on Ukraine. In modern warfare, if there is no accurate IFF, serious friendly casualties will be caused. Therefore, IFF technology is a crucial element of modern military operations, as it helps to prevent friendly fire incidents and enhance situational awareness in highly dynamic and fast-paced environments.

IFF system is used in military and aviation operations to distinguish friendly forces from enemy forces. The main purpose of IFF is to prevent friendly fire incidents where forces accidentally engage and attack their own troops or allies. IFF systems have been in use since World War II (WW II) and have evolved over time to become an essential component of modern military and aviation operations. IFF systems work by transmitting a unique identifier usually in the form of a coded radio signal² from a military aviation platform such as an aircraft, ship, or ground vehicle. The identifier is then received and processed by other military or aviation platforms in the vicinity which use the information to determine

1. George Cahlink, “Better Blue Force Tracking”, AIR FORCE Magazine/June 2004, Available at: <https://www.airandspaceforces.com>.

2. Monika Choudhary and Jyoti Chauhan, “Identification of Friend or Foe Radar”, International Journal of Advance Research in Science and Engineering, Vol. No.2, Issue No.9, September 2013, Available at: <http://www.ijarse.com>.

the platform's status as either friendly or unfriendly. This whole procedure is very critical in reducing the risk of friendly fire incidents where friendly forces are inadvertently targeted or engaged, which can result in significant loss of life and damage to military assets.

Research Hypothesis

Advancements in IFF technology have significantly enhanced military operations by enabling accurate identification and differentiation between friendly and hostile forces. The existing literature on IFF technology primarily focuses on specific technical aspects, with limited comprehensive studies encompassing the multifaceted dimensions of IFF systems in the context of modern warfare. This journal aims to bridge this research gap by providing a holistic examination of the subject matter.

Research Methodology

The research design for this study is a combination of qualitative and quantitative approaches. This mixed-methods approach has provided a comprehensive understanding of the evolution and role of IFF technology in modern warfare. The data collection process will involve the following methods:

- a. **Literature Review** : A systematic review of relevant literature was conducted to gather information on the historical development, technological advancements, operational implications, and strategic considerations of IFF technology. This includes scholarly articles, academic journals, conference papers, and reports from reputable sources.
- b. **Document Analysis** : Military doctrines, policies, and publications from different armed forces have been analyzed to understand how IFF technology is integrated into military operations and strategies. This analysis has provided insights into the implementation and utilization of IFF systems.
- c. **Case Studies** : Case studies of specific military operations and engagements where IFF technology played a significant role will be examined. These case studies will provide real-world examples and practical implications of IFF technology in modern warfare.

Data Analysis

The data collected through literature review, document analysis and case studies will be analyzed using qualitative and quantitative methods :

- a. **Qualitative Analysis** : Thematic analysis was employed to identify patterns, themes, and key concepts from the literature review, document analysis, and interview transcripts. This analysis will provide a deeper understanding of the evolution, operational implications, and strategic considerations of IFF technology.
- b. **Quantitative Analysis** : Quantitative data, such as statistics and numerical data related to the effectiveness of IFF technology, was analyzed using statistical techniques. This analysis will help quantify the impact of IFF technology on reducing friendly fire incidents and enhancing operational effectiveness.

History and Chronological Development of IFF System

IFF system has evolved over time since 20th century with new technologies and advancements incorporated to make the system more effective and efficient. Chronological overview of the development of IFF systems has been described below in brief :

- a. **WW II** : During WW II, the first IFF system was introduced, using simple coded signals transmitted from military platforms. The British Royal Air Force (RAF) developed the first IFF system, known as Radio Identification Friend or Foe" (RIF)³. The system worked by transmitting a coded signal from the aircraft, which could be received and decoded by ground-based radar systems. This helped to reduce the risk of friendly fire incidents and allowed for more efficient coordination of air operations. These early IFF systems were primarily used by aircraft, and were designed to prevent friendly fire incidents between allied aircraft. In the last phase of WW II, the Americans had also started to use the IFF system.

3. Ricchard Trim OBE, "Air Defence 1940-19101 Military IFF and Secondary Radar - A Historical Review", Available at: <https://journals.sagepub.com/doi/pdf/10.1177/002029400303600804>.

b. 1950s-1960s : In the 1950s and 1960s, IFF systems were further developed and improved, with the introduction of more advanced coding techniques and the use of multiple frequency bands. The first ground-based IFF systems were also developed during this time, and were used to control access to airbases and other sensitive areas by western world. During this period, IFF systems became more sophisticated and incorporated the use of encryption and various modes of operation. The United States (US) military, developed the Mark X⁴ IFF system, which became the standard IFF system used by the US Air Force and US Navy.

c. 1970s-1980s : In the 1970s and 1980s, the development of IFF systems has continued, with a focus on increasing the reliability and security of the systems. The advent of microelectronics and digital processing marked a major turning point in the development of IFF systems. During this time, new IFF systems were introduced that used digital coding and encryption to provide advanced security and reliability. Finally, in 1978, the US military introduced the "Mark XII⁵ IFF" system, which was designed to be more secure and resistant to jamming.

d. 1990s-2000s : In the 1990s and 2000s more development of advanced IFF systems has come to light, such as the "Mode 4" system, which used encrypted transponder signals to provide enhanced security. The increased use of stealth technology and the threat of electronic warfare (EW) also prompted the development of more sophisticated IFF systems, Mark XIIA⁶, known as "Mode 5" system. The widespread adoption of Global Positioning System (GPS) technology had a significant impact on the development of IFF systems in this era. GPS technology was integrated into IFF systems, allowing for improved accuracy and enhanced situational awareness for military and aviation platforms.

4. E. F. Freeman, "The IFF Mark X [SIF] Air Traffic Control Radar Beacon System Performance Prediction Model", IIT Research Institute, September 1969, Department of Defence, Electromagnetic Compatibility Analysis Centre, Available at: <https://apps.dtic.mil/sti/pdfs/AD0694569.pdf>.

5. Available at: <https://www.globalsecurity.org/military/library/policy/navy/ntsp/Aims-mk-xii-iff.htm>.

6. Available at: <https://www.dote.osd.mil/Portals/97/pub/reports/FY2013/navy/2013mkxiiiaiffmode5.pdf?ver=2019-08-22-111216-237>.

e. **2010s - onwards** : The development of IFF systems has focused on increasing their capabilities, including the use of encrypted data links and improved identification algorithms. In the current era of modern warfare, IFF systems continue to play a critical role in ensuring the safety and efficiency of military operations. With the increasing threat of electronic warfare and the proliferation of unmanned aerial systems, the importance of IFF systems has only increased, making the development and implementation of these systems a top priority for military forces worldwide. There has also been a growing emphasis on the development of interoperability between different IFF systems used by different nations and different platforms of military forces.

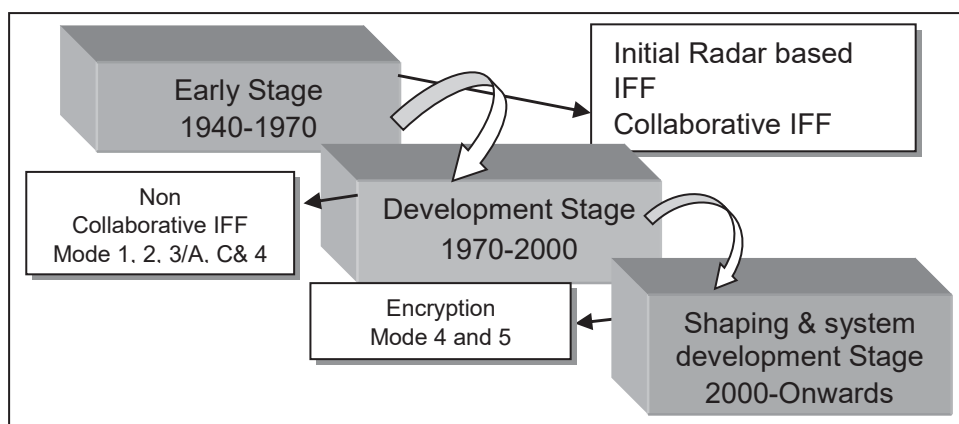


Figure 1: Chronological Development of IFF System

Working Modes of a Modern IFF System

Modern IFF systems work in different ways to provide necessary information to military command and control they need. The use of multiple IFF modes⁷ is crucial for ensuring the safety and effectiveness of military operations in modern warfare. By accurately identifying friendly units and preventing hostile

7. Available at: https://www.globalsecurity.org/military/library/policy/navy/nrtc/14089_ch3.pdf.

forces from interfering with the system, military forces can maintain a high level of situational awareness and respond quickly and effectively to changing circumstances on the battlefield. Different IFF modes of operation are :

- a. **Mode 1** : This is the most basic mode of IFF and is used primarily for air traffic control (ATC) purposes. In this mode, an IFF transponder sends a four-digit code that is used to identify the aircraft.
- b. **Mode 2** : This mode provides more detailed information about the aircraft, including its altitude. Mode 2 is often used in military environments, where accurate altitude information is critical for aircraft separation and collision avoidance.
- c. **Mode 3/A** : This mode is similar to mode 2, but it also provides the four-digit octal (12 bit) identification code for the aircraft, assigned by the air traffic controller. Commonly referred to as a squawk code. In addition, mode 3/A is widely used in military air defense systems.
- d. **Mode C** : This mode of the IFF system is used in ATC systems. Mode C specifically provides the highly accurate altitude information of the aircraft in real-time. This information is critical for ATC, as it helps air traffic controllers to separate aircraft and ensure safe flight operations.
- e. **Mode S** : Mode S is a newer IFF mode that provides additional information, such as the aircraft's flight number, speed, and heading. Mode S is used in ATC systems to enhance air traffic management and improve situational awareness.
- f. **Mode 4** : Mode 4 is an advanced mode of IFF and provides secure identification. It uses encrypted codes to ensure that only authorized friendly forces can receive the information transmitted. This mode is used in highest-threat battle environments, such as in the vicinity of enemy territory.

g. **Mode 5** : Mode 5⁸ is the latest and most advanced mode of the IFF system. It is used in military air defense and ATC systems to provide highly accurate and timely information and secure and reliable identification of friendly forces. Mode 5 improves upon previous IFF modes by incorporating advanced cryptographic techniques to ensure secure and reliable identification. This includes the use of encrypted codes and digital signatures, which help to prevent unauthorized access to the IFF system and ensure that only authorized friendly forces can receive the information transmitted. Mode 5 also includes a data link capability, which allows the exchange of real-time data between aircraft, ground control systems, and other military assets. This enhances air traffic management and improves the coordination of military operations.

Complexity of Modern War Scenario

The scenario of the war field is very complex and always challenging, with many different factors that can contribute to fratricide, or friendly fire incidents. One of the key challenges is the fast-paced and dynamic nature of modern warfare, where the situation on the battle ground can change rapidly and unexpectedly. In this context, the IFF system plays a critical role in reducing the risk of fratricide. By providing accurate and timely information about the identification and location of friendly forces, the IFF system helps military personnel to make informed decisions about the use of force and reduces the risk of accidentally engaging friendly forces. However, despite the important role that the IFF system, there are still several challenges that can contribute to fratricide in modern warfare. There are a few examples given below :

a. **EW** : The use of electronic jamming and other forms of EW can interfere with the IFF system and prevent it from functioning correctly. This can increase the risk of fratricide, as friendly forces may not be able to accurately identify each other.

8. Available at: <https://euro-sd.com/2022/01/articles/exclusive/24434/identification-friend-or-foe/>.

b. **System Interoperability** : Both commercial and military organizations of many nations may use different IFF systems, which can create interoperability issues and increase the risk of fratricide. To effectively mitigate fratricide, it is pivotal that IFF systems be designed with interoperability in account.

c. **Human Factors** : Despite the advanced technology of modern IFF systems, human factors still play a critical role in reducing the risk of fratricide. For example, aircrews must be properly trained in the use of the IFF system and must follow recognized procedures to minimize the risk of fratricide.

Different Fratricide Events Due to The Limitation of IFF Technology

Fratricide, or friendly fire incidents, have been a persistent challenge throughout the history of warfare, including WW I and WW II. In these conflicts, the use of IFF systems was limited, and fratricide was a common occurrence. There are a few examples of fratricide incidents that occurred during WW II due to limitations⁹ in IFF technology, as given below:

a. **Battle of Britain** : During the Battle of Britain in 1940, friendly fire incidents were a common occurrence due to the limited capabilities of IFF systems at the time. British and German fighter aircraft often found themselves engaging each other in close quarters, with limited ability to distinguish between friend and foe.

b. **D-Day** : On D-Day the largest amphibious invasion in history, friendly fire incidents were a serious concern. The limited IFF capabilities of the time meant that friendly aircraft and naval vessels could not be easily distinguished from enemy forces, leading to instances of friendly fire.

9. George Cahlink, Op Cit.

10. Ryan Pickrell, "D-Day by the Numbers: Pulling Off the Biggest Amphibious Invasion in History", Business Insider, 5 June 2019, Available at: <https://www.military.com/off-duty/2019/06/05/d-day-numbers-pulling-biggest-amphibious-invasion-history.html>.

c. **Pacific Theater** : In the Pacific Theater, friendly fire incidents were a persistent problem due to the limited visibility and challenging terrain. As a result of limited use of IFF system many friendly fire incidents occurred.

Although the modern IFF system has significantly reduced the risk of fratricide, or friendly fire incidents, there have been instances where fratricide has occurred due to limitations or failures in the IFF system. There are a few examples of modern fratricide incidents along with statistics of friendly casualties of 20th century that have occurred due to limitations or failures in the IFF system, has been given below in figure 2 :

a. **Gulf War** : The first recorded instance of fratricide due to IFF occurred during the Gulf War. On February 27, 1991, an American F-15 fighter jet fired a missile at a US Army Blackhawk helicopter, killing 26 people on board. The F-15's IFF system failed to recognize the Blackhawk as a friendly aircraft.

b. **Operation Desert Storm** : During Operation Desert Storm¹¹ in Iraqi war on 1991, a number of fratricide incidents occurred due to limitations in the IFF system. Some friendly aircraft were not properly equipped with IFF transponders, or the transponders were not properly configured, leading to instances of friendly fire and damage entirely.

c. **Kosovo War** : During the Kosovo War on 1991, a US Navy F-18 fighter jet shot down a US Air Force F-16 fighter jet, killing the pilot. The F-18's IFF system failed to recognize the F-16 as a friendly aircraft.

d. **Afghanistan War** : During Afghanistan war¹², friendly fire incidents have been a persistent challenge due to the limitations of the IFF system in the challenging operational environment in different timeline. On March 4, 2002, during Operation Anaconda in eastern Afghanistan, a US Air Force

11. Larry Doton, "Integrating Technology to Reduce Fratricide", Acquisition Review Quarterly-Winter 1996, Available at: <https://apps.dtic.mil/sti/pdfs/ADA487939.pdf>.

12. Lisa M. Allen, "The Surge in "Green-on-Blue" Attacks in Afghanistan", Counter Terrorist Trends and Analyses, Vol. 4, No. 11, November 2012, pp. 7-9, Available at: <https://www.jstor.org/stable/26351099>.

F-16 fighter jet dropped a laser-guided bomb on a group of US Army Rangers, killing three and injuring 20 others. Similar fratricide events also occurred during ‘Helmand Province Incident’, ‘Kandahar Incident’, ‘Panjwai Incident’, etc. Some incidents have been attributed to failures in the IFF system, including the inability to properly identify friendly forces in the close quarters of urban warfare. Again, In April 2002, a US Navy F-14 fighter jet dropped a bomb on Canadian troops conducting a live-fire training exercise in Afghanistan, killing four soldiers and injuring eight others. The F-14's IFF system did not detect the Canadian soldiers on the ground.

e. **Operation Iraqi Freedom** : In Operation Iraqi Freedom¹³ on 2003, fratricide incidents during ‘Battle of Nasiriyah’, ‘Al Tawfik Bridge Incident’, ‘Checkpoint Incident’, and some other incidents were a persistent concern due to limitations in the IFF system and the challenges of identifying friend from foe in the complex and dynamic operational environment. In March 2003, a US Patriot missile battery shot down a British Tornado GR4 fighter jet, killing both crew members. The Patriot's IFF system identified the Tornado as an enemy aircraft. Some incidents of friendly fire were attributed to limitations in the IFF system, including failures in the transponders and incorrect configurations of the system.

f. **Syrian Civil War** : During the civil war of Syria on 2016, a coalition airstrike targeting ISIS militants accidentally hit Syrian government forces, killing over 60 soldiers. The US military later admitted that the incident was due to a misinterpretation of the IFF system, which incorrectly identified the Syrian soldiers as enemy combatants.

g. **Airstrike in Idlib, Syria** : In February 2018, a Russian Su-25 fighter jet was shot down by Syrian rebels¹⁴ using a man-portable air defense system (MANPADS). The Russian Defense Ministry claimed that the Su-25's IFF system was not activated at the time of the incident.

13. Col Mandeep Singh, “Of Fratricide and Air Defence Command”, Indian Defence Review Blog, 11 June 2020, Available at: <http://www.indiandefencereview.com/of-fratricide-and-air-defence-command/>.

14. Available at: <https://www.businessinsider.com/syrian-rebels-reportedly-shoot-down-russian-su-25-pilot-unknown-2018-2>.

h. India-Pakistan Kashmir Conflict : The Mi-17 helicopter was shot down in Budgam, Kashmir Valley, by an Indian Air Force surface-to-air missile, killing all seven people on board as well as a civilian on the ground. The Indian Air Force accidentally shot down one of its own helicopters in Kashmir on February 27, 2019 during a fierce battle between Indian and Pakistani forces. Indian Government termed the incident as “Mistaken Fratricide”¹⁵.

j. Nagorno-Karabakh Conflict : During the Nagorno-Karabakh conflict in 2020 between Armenia and Azerbaijan, an Armenian military helicopter was shot down by an Azerbaijani missile, killing all three crew members on board. The Azerbaijani military claimed that the helicopter was mistaken for an enemy aircraft due to a malfunction in their IFF system.

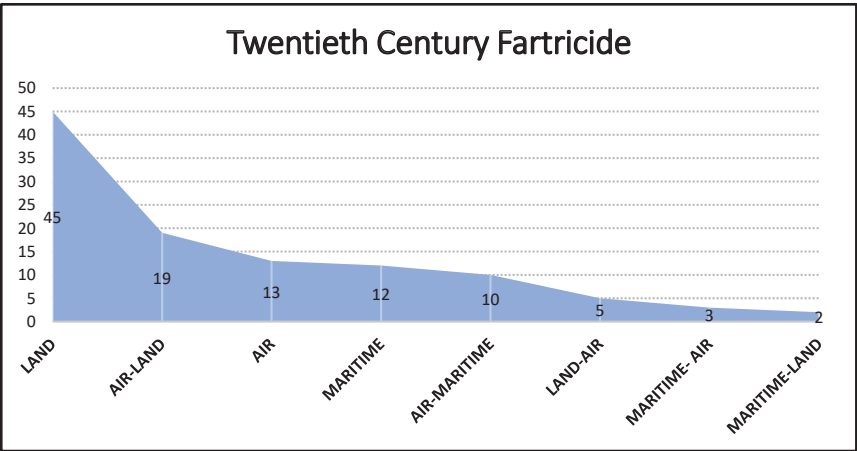


Figure 2: Statistics¹⁶ of Friendly Casualties in 20th century

15. Available at: <https://www.ndtv.com/india-news/budgam-crash-shooting-down-of-chopper-in-feb-was-case-of-mistaken-fratricide-centre-2135948>

16. John Bourn, “Ministry of Defence: Combat Identification, Report by the Comptroller and Auditor General HC 661 Session 2001-2002, 7 March 2002”, National Audit Office, UK, Available at: <https://www.nao.org.uk/wp-content/uploads/2002/03/0102661.pdf>

Necessity of Modern IFF System

The modern IFF system is a critical component of modern military operations, ATC, and air defense systems. The necessity of the IFF system arises from the need to accurately identify and track friendly forces in complex and dynamic operational environments. The necessity of IFF systems in modern warfare is due to several factors, including:

- a. **Avoiding Friendly Fire Incidents :** One of the primary purposes of IFF systems is to prevent friendly fire incidents, where friendly forces accidentally attack each other. With the fast-paced nature of modern warfare, and the increased use of unmanned aerial systems and other advanced technology, the risk of friendly fire incidents has only increased. IFF systems provide a quick and reliable method of identifying friendly aircraft and vehicles, reducing the risk of such incidents.
- b. **Improved Situational Awareness :** IFF systems provide military commanders with a more accurate picture of the battlefield, helping them to make more informed decisions. By identifying friendly aircraft and vehicles, IFF systems allow military commanders to better track the movement of friendly forces and to coordinate their actions more effectively.
- c. **Countering EW :** EW is a growing threat in modern warfare, with potential enemies using jamming and other electronic countermeasures to interfere with military communications and radar systems. IFF systems that incorporate encryption and other security measures can help to counter these threats, ensuring that friendly aircraft and vehicles can be reliably identified even in the presence of electronic jamming.
- d. **Enhanced Security :** In modern warfare, there is a need for increased security due to the threat of cyber attacks and other forms of espionage. IFF systems that use encrypted transponder signals can provide enhanced security, helping to ensure that only authorized parties can access the information being transmitted.

e. **Improved Interoperability** : With the increased use of international coalitions in modern warfare, it is important to ensure that different military organizations can communicate and coordinate their actions effectively. IFF systems that are standardized and used by multiple nations can help to improve interoperability, allowing for more effective cooperation between friendly forces.

Necessity to Develop Indigenous IFF by a Nation

To develop an indigenous IFF system is always a complex and challenging as it requires significant expertise in various technical areas. Some of the key steps that a nation might take to develop an indigenous IFF system and which includes defining the requirements, conducting necessary research and development, build and test prototypes and after obtaining pertinent certification, deploying the system in different platforms. A simplified block diagram describing different stage to develop an indigenous IFF system has been shown in figure 3 below :

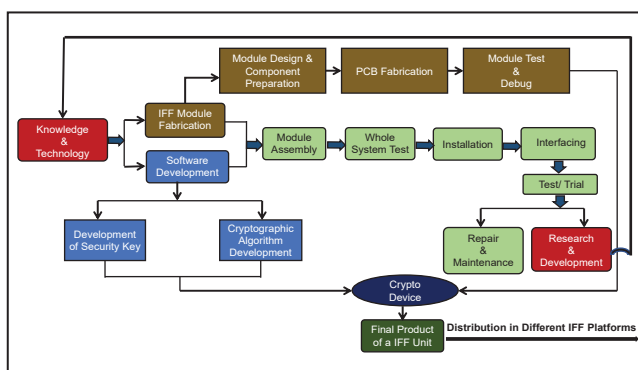


Figure 3 : Indigenous stages/ steps to Develop an IFF System by a Nation

Developing an indigenous IFF system can be an important strategic priority for a nation for several reasons:

a. **Security** : An indigenous IFF system can enhance a nation's security by providing a reliable means of distinguishing friendly forces from potential adversaries. This can help prevent incidents of friendly fire and reduce the risk of accidental engagement.

b. **Sovereignty** : Developing an indigenous IFF system can also help a nation assert its sovereignty and reduce dependence on foreign technology. It can provide a sense of self-reliance and independence, which can be important for a nation's pride and identity.

c. **Customization** : An indigenous IFF system can be tailored to meet the specific needs and requirements of a nation's military forces. This can help optimize the system's performance in a given environment and ensure that it is compatible with other indigenous technologies.

d. **Economic Benefits** : Developing an indigenous IFF system can also have economic benefits. It can provide opportunities for local industries to develop and manufacture the necessary components, leading to job creation and economic growth.

e. **Technological Advancement** : Developing an indigenous IFF system can also spur technological advancement in a nation. The development of new technologies and techniques required for the system can lead to advances in other areas, such as communications, signal processing, and electronics.

Effective Use of IFF System

By implementing following measures, military organizations can help ensure the effective use of IFF systems, which can help prevent friendly fire incidents and enable effective coordination and cooperation among allied forces in multinational operations:

a. **Adherence to Technical Standards and Protocols** : IFF systems must comply with established technical standards and protocols to ensure interoperability with other systems and prevent confusion or misidentification of friendly and hostile forces.

b. **Regular Testing and Maintenance** : IFF systems should be regularly tested and maintained to ensure their proper functioning and accuracy. This includes periodic checks of hardware and software components, as well as testing in simulated and live operational environments.

c. **Training and Education** : Military personnel who operate IFF systems should receive comprehensive training and education on the proper use and interpretation of the system, including how to respond to IFF alerts and warnings.

d. **Communication and Coordination** : Effective communication and coordination among military units is critical to ensuring the proper use of IFF systems. This includes clear and timely transmission of IFF information and alerts, as well as effective coordination among air and ground units to prevent friendly fire incidents.

e. **Continuous Improvement** : IFF systems should be continually evaluated and updated to incorporate new technologies and improve their effectiveness. This includes ongoing research and development of new IFF technologies and protocols, as well as analysis of IFF performance in operational contexts.

Steps of Bangladesh to Adopt this Challenging IFF Technology

Keeping pace with technological advancements of the globe, Bangladesh has inaugurated IFF Centre in Chattogram in December 2018 under the supervision of Armed Forces Division, where Bangladesh Navy act as a leading organization to adopt this IFF technology. To adopt this technology more effectively we need careful planning, coordination, and implementation. Here are some steps which we should follow to adopt IFF technology:

a. **Define the Scope** : The scope of IFF center should be defined. This includes the geographic area it will cover, the types of platforms it will support, ensure interoperability among the platforms and the specific requirements for the IFF system.

b. **Develop a Plan** : A plan should be developed that outlines the implementation strategy, the system architecture, and the procurement process. This should also include a budget and a timeline for implementation.

c. **Procure the Necessary Equipment** : The next step is to procure the necessary equipment for the IFF center. This includes IFF transponders, radars, and other necessary hardware and software.

d. **Install and Test the System** : Once the equipment has been procured, it should be installed and tested to ensure that it is operating correctly and in compliance with international IFF standards.

e. **Skilled Manpower** : It is important to train personnel on the operation and maintenance of the IFF system. This includes training on the equipment, as well as training on IFF procedures and protocols. Personnel from all three defense forces (Army, Navy, and Air Force) must be trained together in order to develop skills and effectively use the IFF system.

f. **Establish Maintenance and Update Procedures** : Once the IFF center is fully operational, it is important to establish maintenance and update procedures to ensure that the system remains effective and up-to-date. This includes regular testing and calibration, as well as updates to software and hardware as required.

g. **Ensure Compliance** : Finally, it is important to ensure compliance with international standards and regulations for IFF technology, such as those established by NATO and the International Civil Aviation Organization (ICAO).

h. **Research and Development** : Developing an IFF system is a complex task that requires significant research and development efforts. The system should be continuously developed in order to keep pace with worldwide technological advancement and to ensure successful and long-term use of the system. This includes research into the latest technologies and approaches for IFF systems, as well as testing and evaluation of prototypes.

Future Development of IFF System

The future development of IFF systems in respect to different domains, such as underwater, surface, sub-surface, air, and space, will depend on the specific

needs and challenges of each domain. As technology continues to evolve, the future development of IFF systems will likely focus on the following areas:

- a. **Improved Accuracy and Reliability** : As we know, future threats will be more sophisticated, thus IFF systems must be able to identify friendly forces accurately and reliably. Future IFF systems will likely use advanced algorithms and machine learning techniques to improve accuracy and reduce false positives (Identifying a friendly target as an enemy or potential threat).
- b. **Increased Interoperability** : IFF systems need to work seamlessly across different platforms and systems to enable effective communication and coordination between different units. Future IFF systems may incorporate open architecture and standardization to ensure compatibility across different systems and platforms.
- c. **Enhanced Cybersecurity** : With the growing threat of cyber-attacks, future IFF systems need to be designed with strong cybersecurity features to prevent unauthorized access and hacking. This may include advanced encryption technologies and authentication mechanisms.
- d. **Integration With Other Systems** : IFF systems can be integrated with other military technologies such as radar, sonar, and GPS to provide a comprehensive situational awareness picture. In the future, IFF systems may be further integrated with other technologies like tactical data link (TDL) to provide a more complete and accurate view of the battlefield.
- e. **Miniaturization** : With the trend towards smaller and more portable military equipment, future IFF systems may need to be miniaturized to enable deployment in smaller and more mobile platforms such as unmanned aerial vehicles (UAVs)¹⁷.

17. Omid Sharifi-Tehrani, Alireza Sadeghi and Seyyed Mohammad Javad Razavi, "Design and Simulation of IFF/ ATC Antenna for Unmanned Aerial Vehicle", Majlesi Journal of Mechatronic Systems, Volume. 6, No. 1, March 2017, Available at: <https://www.researchgate.net/publication/317637624>.

f. **Integration with Artificial Intelligence (AI)** : AI can be integrated with IFF technology to improve its accuracy and efficiency. For example, AI algorithms can be used to analyze large amounts of data from different sensors and platforms to identify patterns and anomalies that could indicate potential threats. AI can also be used to automatic classification of objects and predict their behavior based on past data, which can help reduce false alarms and increase the accuracy of the system.

g. **Internet of Things (IoT)** : IoT will dictate entire IFF technology in near future. We need to accommodate ourselves with IoT to get better output from IFF system. There are some potential applications where IFF technology and IoT could be integrated. For example, in military applications, IFF systems could be connected to other sensors and devices on the battlefield, providing a more complete picture of the operational environment. This could include data from unmanned aerial vehicles, ground sensors, and other devices. In addition, IoT devices could be used to improve the accuracy and effectiveness of IFF systems. For example, sensors could be used to detect and identify specific types of signals, reducing the risk of false positives and other errors. Overall, while there is some potential for integration between IFF technology and the IoT, this is still a relatively new area and there is much more research and development that needs to be done to fully explore the possibilities.

h. **SpaceX** : SpaceX¹⁸ is the private space exploration company founded by Elon Musk, may also be related to IFF technology through its work with the U.S. government and their defence forces. SpaceX has contracts with various government agencies, including the US Space force, US Air force and NASA, to provide launch services and develop advanced space technologies. IFF technology is an important part of space defense systems to ensure that spacecraft and other objects in orbit are identified correctly and do not pose a threat to other satellites or spacecraft.

18. Available at: <https://www.spacex.com/mission/>.

j. **Fourth Industrial Revolution (4IR) :** 4IR is a term used to describe the current wave of technological advancements, including AI, robotics, IoT, and other digital technologies. IFF technology is a part of this revolution as it relies on digital communication and data processing to identify objects and avoid conflicts. As AI and other digital technologies continue to evolve, IFF technology will also continue to improve, making it a critical part of future military and commercial applications.

k. **Domain-Specific Needs :** Depending on the domain, there may be specific needs that future IFF systems need to address. For example:

(1) **Underwater :** In underwater environments, acoustic signals are used for communication and identification. Future underwater use of IFF systems may need to focus on developing more advanced and reliable acoustic signaling techniques.

(2) **Surface :** In surface environments, IFF systems may need to address the challenge of identifying and tracking fast-moving objects such as ships and aircraft.

(3) **Sub Surface :** In sub-surface environments, IFF systems may need to address the challenge of identifying and tracking submerged objects such as submarines and torpedoes.

(4) **Air :** In air environments, IFF systems may need to address the challenge of identifying and tracking aircraft in crowded airspace and avoiding collisions.

(5) **Space :** In space environments, IFF systems may need to address the challenge of identifying and tracking spacecraft and debris in orbit.

Conclusion

The evolution and indispensable role of Identification Friend or Foe (IFF) technology in reinforcing national security in modern and complex warfare scenarios cannot be overstated. Throughout history, IFF systems have continually

advanced to address the critical need for effective identification and discrimination between friend and foe. From its early beginnings during WW II to the present day, IFF technology has undergone significant developments, incorporating radar-based systems, transponders and advanced EW techniques. These advancements have greatly contributed to enhancing situational awareness, reducing fratricide incidents and improving overall combat effectiveness. IFF system is an important tool for reducing this risk and ensuring that friendly forces can engage the enemy with confidence. To be most effective, IFF systems must be designed with interoperability in mind, protected from EW, and supported by effective training and procedures to reduce the risk of human error.

Fratricide has been a persistent challenge throughout the history of warfare, and the IFF system has played a vital role to reduce the risk of friendly fire incidents. Despite the limitations of IFF technology in WW I and WW II, incidents discussed earlier highlight the importance of continuing to develop and improve IFF systems to reduce the risk of fratricide in modern warfare. Again, modern fratricide incidents due to limitations or failures in the IFF system are relatively rare, but they highlight the ongoing challenges associated with preventing fratricide in complex and dynamic operational environments. The development and improvement of the IFF system remains a critical component of modern military operations, and continued efforts are needed to reduce the risk of fratricide.

IFF systems in modern warfare is essential as it improves safety, situational awareness, security, and interoperability of Warfield. These systems play a critical role in ensuring the success of military operations, and their importance is likely to continue to grow in the future. Again, the necessity of the modern IFF system arises from the need to accurately identify and track friendly forces, manage air traffic, and defend against airborne threats in complex and dynamic operational environments. It is a critical tool for ensuring the safety and success of military operations, ATC, and air defense systems. The future development of IFF systems in different domains will depend on the specific needs and

challenges of each domain, but will likely focus on improving accuracy, interoperability, cybersecurity, integration with other systems, and addressing domain-specific needs. Again, as military operations are becoming increasingly complex and sophisticated, the importance of IFF technology will continue to grow, and its capabilities will continue to evolve to meet the evolving needs of modern military forces.

IFF technology has revolutionized combat effectiveness. Through precise identification of potential threats, selective engagement, and enhanced operational tempo, IFF systems have greatly improved the efficiency and success rates of military missions. By leveraging the capabilities of IFF technology, armed forces can achieve superior operational outcomes and maintain a strategic advantage on the battlefield. However, challenges remain in the implementation and utilization of IFF technology. Ensuring system interoperability, addressing cybersecurity vulnerabilities, and providing comprehensive training are essential to maximizing the effectiveness of IFF systems. Ongoing research and development efforts must continue to address these challenges and advance the capabilities of IFF technology. Looking ahead, the future of IFF technology holds great promise. Integration with emerging technologies such as AI, machine learning, and advanced sensor systems will further enhance its capabilities. These advancements will enable more accurate and reliable identification, better resistance against spoofing, and improved adaptability to evolving threats.

This journal concludes by reaffirming the indispensable role of IFF technology in modern and complex warfare scenarios. It highlights the evolution of IFF systems, their core principles, and the significant impact they have had on enhancing national security. As technology continues to evolve, ongoing research and development efforts will be crucial in advancing IFF systems and ensuring their continued effectiveness in safeguarding military personnel and operations.

Biography of the Writer



Rear Admiral Khandakar Akhter Hossain, NUP, ndc, psc, PhD was commissioned in Engineering Branch of Bangladesh Navy on 01 January 1991. He has completed BSc and MSc Engineering in Naval Architecture and Marine Engineering with distinct result from Bangladesh University of Engineering and Technology (BUET). He has also completed MBA from reputed public university. He did Shipbuilding and Shipyard Management Course both from China and USA. He has achieved prestigious Doctor of Philosophy (PhD) degree both from BUET (On shipbuilding/recycling) and California, USA (On advanced engineering management). He has served as Engineer Officer onboard different war ships including BNS UMAR FAROOQ, BNS ALI HAIDER, BNS BANGABANDHU and BNS SHADHINOTA. He has also served as Deputy Director/Director at NHQ. He successfully participated in UN peacekeeping mission in Sudan. He was the project chief Naval Architecture/Engineer of state of Art warship Shadhinota Class Missile Corvette project in China. He has also served as GM (Shipbuilding), GM (Production) and GM (Planning and Marketing) in all BN owned shipyards. He has performed various instructional duties in Naval Academy, Marine Academy, NIT and MIST. He was also the Dean/Head (On NAME department/ME Faculty) at Military Institute of Science and Technology (MIST). He has served as member Engineering in Chittagong Port Authority. He has successfully performed the duty of Managing Director (MD) in all three shipyards run by BN and has contributed remarkably in national shipbuilding industry. Before joining here, he has performed his duties as Commodore Superintendent of Dockyard (CSD). He is the fellow of prestigious institutes like IEB (BD), RINA (UK) and IAMSP (USA). He has more than one hundred International publications/papers on shipbuilding, ship recycling, energy solution, human management diversification, port operation, AI, IoT and advanced technology in diversified international technical journals. Presently he is serving as Assistant Chief of Naval Staff (Materiel) at Naval Headquarters. He is happily married with Dr. Sharmin and blessed with twin daughters and two sons.



Lieutenant Commander Md Asaduzzaman, (Edn), BN was commissioned in Education Branch of Bangladesh Navy on 07 January 2017. He has completed BSc in Electrical and Electronics Engineering (EEE) from Ahsanullah University of Science and Technology (AUST). Later, he successfully completed Encryption Algorithm Development Course for Identification Friend or Foe (IFF) System from CETC, China under supervision of University of Electronic Science and Technology (UESTC) of China. He has served in Centre for Naval Research and Development (CNRD) and currently he is posted in IFF Centre located in Chattogram.

COMMANDING GENERATION Z IN DIGITAL AGE : CHALLENGES OF MILITARY LEADERSHIP IN CONTEXT OF BANGLADESH ARMED FORCES

Commodore Mirza Ali Akbar Shirazi, (N), OSP, afwc, psc, BN

Abstract

Military leadership is a special kind of leadership. The unique battlefield operating environment and the inherent complexity of its modern systems and equipment have created a technology based culture in armed forces. Presently, military leaders command a group of youngsters with whom they have a generation gap, who are also digitally oriented. Generation Z (Gen-Z) are known as people born within 1995 to 2010. They are the true digital natives who from early youth have been exposed to digital gadgets. For the last few years, this Gen-Z are joining Bangladesh Armed Forces as officers and troops. Converting them to a military person is a challenge for present military leadership. Gen-Zs spend a good amount of time surfing screens, which is also called 'Screen Time'. However, present military services also deal with hi-tech equipment, sensors and armaments. Thus, to operate these equipment, the best choice is Gen-Z. As such, military leadership needs to study and analyze the general behaviour of this generation and adopt new leadership styles to command them and exploit them to the best of their efficiency. The paper made an endeavor to discuss the challenges faced by military leadership in handling Gen-Z in armed forces and suggested a blend of Transactional and Transformational Leadership as a suitable leadership style to handle Gen-Z in digital age.

Introduction

Military leaders exercise their command over a group of combatants who work in a difficult environment, at times putting one's life at risk. The unique battlefield operating environment and the inherent complexity of its modern systems and equipment undeniably have created a technology-based culture in the armed forces. Today, military leadership is becoming more challenging as they have to command a group of youngsters with whom they have a generation gap.

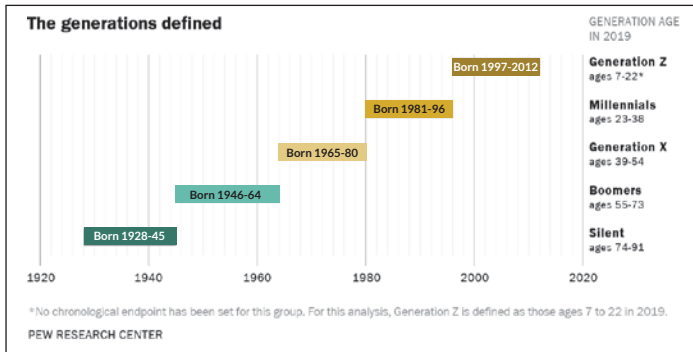
The gap includes age, food habit, culture, custom, perception, access to technology and many more. This gap also creates some problems with understanding of perception between leaders and the led.

Generation Z (Gen-Z) is generally known as the people born between 1995 and 2010 (in some opinion 1997-2012). They are the true digital natives who from the early youth have been exposed to internet, social networks, and mobile phones. For the last few years, these Gen-Z populations have been joining Bangladesh Armed Forces (BDAF) as officers and troops. More so, it becomes a real challenge for the leadership to handle them as they are influenced by all the facets of the digital age. They are more influenced by the virtual world. They are in the habit of using digital gadgets and they spend a good amount of time surfing screens. However, present military services also deal with hi-tech equipment, sensors and armaments. Thus, to operate these devices, the best choice is the Gen-Z. As such, the military leadership needs to study and analyze the general behavior of this generation and adopt new leadership techniques or styles to command them and exploit them to the best of their efficiency. Military leadership needs to look beyond the practiced leadership attributes and develop a new or a modified style to explore the potentials of such a prospective generation and exploit their capability to the highest.

Characteristics of Generation Z - Reasons for Attraction to Digital Gadgets

Gen-Zs are the first digital natives, born in a world of vast technological advancement and innovations. From the very beginning of their life, they are acquainted with smartphones, social media, virtual reality, artificial intelligence etc. This generation is ambitious, industrious, and always on with the changes of technology. Online and social media have opened up the world for Gen-Zers, encouraging them to connect and collaborate with others around the world. At the same time they also allow Gen-Zers to shut out the outside world and live within online communities and echo chambers. The following graph depicts the chronological stages of the generations of different kinds.

Figure 1 : General Birth Year of Different Generations and Their Present Age



Source : Graphical Presentation of Different Generation¹.

Unlike other Gen-Zers, the young members of Bangladesh Armed Forces also prefer technology. They like to spend leisure time with mobiles and computers. They have different types of apps on their smartphones, from where they can even solve professional issues like weather updates, tidal information or astro navigational problems. They are reluctant to outdoor activities and look somewhat easygoing.

Characteristics of Gen-Z

Independent : The key difference between Gen-Z and other generations is, Gen-Zers prefer to work independently. The competitive nature of Gen-Z contributes to them wanting to control their own destiny and not rely on others for their own success². In BDAF, it is observed that young officers and troops prefer independence rather being always under supervision. However, military operations cannot be performed independently because they always require teamwork and a blend of tactical and technical knowledge including experience. In military terms, independent attitude of Gen-Z makes them indisciplined and rebellious at times. They tend to challenge the system, customs and traditions which are otherwise the pride of military services.

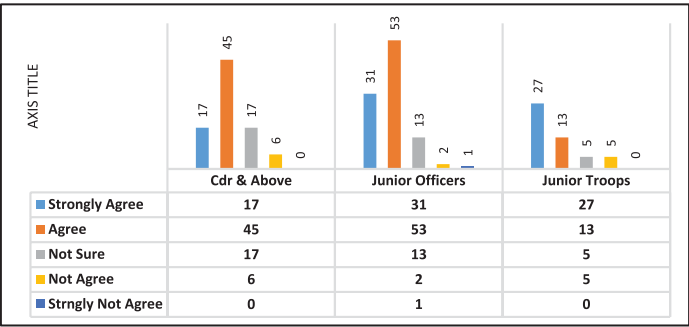
1. "Michael Dimock, Defining Gen: Where Millennials end and Gen-Z begins. 17 Jan 2019. <https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/>".

2. "5 MINUTE READ. 10 Defining Characteristics of Generation Z, JAN 16, 2019. <https://blog.tti-si.com/10-defining-characteristics-of-generation-z>. Accessed on 25 April 2020".

Digital Bonding : Gen-Z is described as having a digital bond to internet and that the internet and smart phones may help them to escape from mental and emotional struggles, they face offline³. This generation started using cell phones initially for entertainment purposes, however gradually they became addicted to it. In military, this generation is found to be better in handling electronic devices without which present modern warfare cannot be thought off. In today’s equipment oriented warfare none but the Gen-Zers are expected to be the best choice to handle the hi-tech complexities.

Target Oriented and Financially Focused : When it comes to work, Gen-Z views their job as a means to an end. Unlike their other counterparts, who often need to love what they do, Gen-Z understands that work is performed for career or financial reasons. The following graph denotes the target-oriented attitude of the Gen-Z. 79.14% agreed upon that the Gen-Z are Target Oriented.

Figure 2 : Agreement of all Categories Survey Participants that Gen-Z are Target Oriented and Financially Focused



Source : Survey Conducted by the Author

Smart and Easygoing : Gen-Z are more pragmatic and analytical in decision making. Before buying anything, they access and evaluate information, reviews, and their own research. In military also, it is expected that this generation will be able to be more analytical in choosing weapon systems,

3. “How to understand and manage Generation Z. <https://blog.peoplespheres.com/how-to-understand-and-manage-generation-z>. Accessed on 28 Apr 2020”.

armaments and equipment. They're more comfortable absorbing knowledge online than in traditional institutions of learning. However, this also makes them easygoing in professional matters.

Competitive : Competition constantly drives Gen-Z. They possess less patience, knowing that they have to act quickly to get what they want fearing someone else may beat them to the punch⁴. This personality profile of young officers and troops can be utilized to get the best out of them, which will eventually give better dividends to the armed forces. The competitive attitude of the youngsters would certainly improve operational, organizational, psychological and combat capability of BDAF⁵.

Reasons for Attraction to Digital Gadgets

Attachment to digital gadgets is a common phenomenon for the young generation in the present context. The Gen-Z were born in a society or time when technology was spreading all over the world. There may be numerous reasons for being attached to digital gadgets from which few are mentioned below :

- a. Parental Laxity.
- b. Maintaining Social Status.
- c. Socio Economic Changes.
- d. Lack of Playground/ Outdoor Activities.
- e. Impulse to Stay Connected Virtually.
- f. Technological Advancement.
- g. Easy Access to Virtual Entertainment.
- h. Cultural Aggression.

4. "5 MINUTE READ. 10 Defining Characteristics of Generation Z, JAN 16, 2019. <https://blog.tti-si.com/10-defining-characteristics-of-generation-z>. Accessed on 25 April 2020".

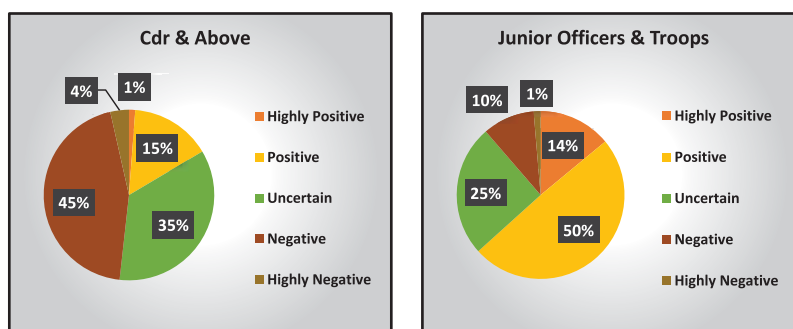
5. "Interview, Commanding Officer, BNS SOMUDRA JOY, Capt (now Commodore) Mohammed Asaduzzaman, (ND), psc, BN, over mobile phone. Interviewed on 12 June 2020".

Impacts of Screen Time Attachment on Professional Life of Generation Z in the Bangladesh Armed Forces

The technological advancement has made a cell phone no less than a computer today. “In January 2024, there were 77.36 million interneters, 53 million social media users and 188.6 million active cellular mobile connections in Bangladesh which is 44.5%, 30.4% and 108.5% of the total population respectively”⁶. Since invention, the changes made in terms of facilities of cell phones are enormous. Thereby, every able individual, capable to purchase a cell phone started possessing one to avail maximum facilities in one gadget to make his/ her life easy and useful.

Gen-Z are the prime users of gadgets from their childhood. Gen-Zers of BDAF also fall on the same category. Almost all of them use at least a smart phone if not a tablet or a laptop. Good number of young officers possesses a laptop whereas the officers of Gen-X used to prefer a motor bike at their youth. The technologically sound Gen-Z are easy to work with in the Ops Room but they are reluctant to exhibit same performance in outdoor activities. Though the effect of screen time is negative on Gen-Z in Bangladesh Armed Forces, but their talent can be utilized for the betterment of the services.

Figure: 3: Comparison- Mid-Level Officers VS Junior Officers and Troops on Impact of Screen Time on Junior Officers and Troops



Source: Survey Conducted by the Author

6. “Simon Kemp, Digital 2024: Bangladesh, 23 February 2024, <https://datareportal.com/reports/digital-2024-bangladesh>. Accessed on 03 Sep 2024”.

Positive Impact : Some positive impacts of screen time are:

- a. Easy Knowledge Assimilation.
- b. Technical Expertise.
- c. Easy to Work With.
- d. Easy Access to Information.
- e. Software/ Apps Based Working Capacity.

Negative Impact : Some negative impacts of screen time are:

- a. Degradation of Professional Knowledge.
- b. Breach of Information Security.
- c. Decline in Service Discipline.
- d. Degradation of Mental Capacity and Decline in Thinking Process.
- e. Non Adherence to Moral and Ethics.
- f. Reluctant to Outdoor Activities.

Challenges of Military Leadership to Handle Gen-Z in the Digital Age

Gen-Z is the demographic cohort succeeding Millennials and preceding generations⁷. There is a two-generation gap between present military leadership and Gen-Z. The challenges of military leadership in handling Gen-Z largely lie in the problem identification, generation gap analysis and understanding the psyche of Gen-Z. Today's Gen-Z moves toward adulthood with a changing view on a range of issues, from governance to racial equality, from blind folded following to justification of action. Therefore, a careful analysis is required to find out the challenges to handle them, and then a solution has to be figured out to reap the best out of them :

7. ""The Science of Population".demographicpartitions.org

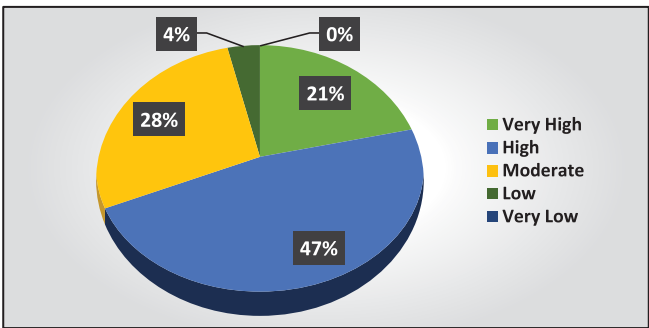
a. Maintaining Operational Efficiency of Armed Forces : In the digital age, Operational Environment (OE) is much more complex. “The complexity of the battlespace, speed of change, and cognitive demands of integrated information networks all conspire to burden leadership in ways that were inconceivable less than a generation ago”⁸. To fight in such OE, hi-tech equipment is a must. Only technically sound personnel will be able to operate such equipment and precision munitions. Gen-Zers in BDAF are capable of operating and maintaining such hi-tech equipment, but they lack on in-depth study and troubleshooting of those. Making youngsters fully capable of operating, maintaining and troubleshooting present day hi-tech military equipment is challenging for the military leaders.

b. Organizational Challenges : Strength or weakness of military structure depends on conditions and climate generated by the organizations. When officers and men join the services from a civil background, they are pushed into an environment where they have to make major adjustments to their personality pattern. Whether they turn out to be useful or not depends to a large extent on the organizational climate in which they are nurtured. For present day subordinates, a conducive environment to work efficiently may be defined as a fearless environment where they can perform their job without fear of punishment and without over supervision.

c. Maintaining Service Discipline and Routine : Gen-Zers are somewhat reluctant in maintaining a routined life. Gen-Zers in armed forces are not exception because anything in the society will have its impact on military as part of the societal system. Survey results showed that 96% of the mid-level leaders admitted maintaining service routine and discipline have become one of the prime challenges for them (leaders) to handle Gen-Z in the armed forces.

8. “Commander Christopher D. Hayes, Developing the Navy’s Operational Leaders- US Naval War College Review, summer 2008, Vol. 61, No 3, <https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1817&context=nwc-review>. Accessed on 24 May 2020”.

Figure 4 : Rate of Challenge on Maintaining Service Discipline and Routine



Source : Survey Conducted by the Author

d. Upholding Professional Standard of the Under Commands (UCs) :

Majority of Gen-Zers in BDAF don't study professional books which ultimately causes a negative impact on their professional knowledge. Survey in this study reveals that, out of 85 mid-level officers, 55 pronounced the degradation of professional standards of Gen-Zers in BDAF has become a big challenge for military leaders to run a technology based armed forces.

Figure 4 : Rate of Challenge on Maintaining Professional Knowledge of Gen-Z



Source : Survey Conducted by the Author

e. Combating Social Crime :

Excessive use of mobile phones diverts Gen-Z towards unethical affairs, online gambling and other social Misconduct. In the past, many of them got addicted to drugs. Bangladesh Armed Forces have taken strong stand against these crimes. Commanding

Officers are found to be worried on this particular issue because none of them want to deal with such administrative problem which is otherwise an impediment for the operational efficiency of the unit.

f. Preserving Service Customs and Traditions : Military all over the world hold some customs and traditions. Traditionally, armed forces personnel like to stay in groups. Bachelors used to pass leisure hours gossiping among themselves or going out for a ride or a dinner in a group. Visiting senior officers' residence, inviting families in the Officers' Mess was a regular phenomenon in Bangladesh Armed Forces when Gen-X were young. In present days, screen time addiction has made youngsters self-centric and lonely. For example: enjoying a movie on the mobile phone with a headphone in the ear is more preferable to them than enjoying it on large TV with their peers in the anti-room. This is how slowly and gradually the service customs and traditions are being threatened.

g. Conserving Moral/ Ethical Values : Materialistic mindset coupled with an increased focus on career advancement has significantly changed the moral values of military personnel. Recently, over cautiousness and self-interest-oriented attitudes are marked amongst junior officers and troops. This has led to a culture where individuals are more focused on avoiding blame than taking responsibilities, yet eager to claim credit for any success. "The general trend has become to hold the ladder by appreciating 'when to jump, where to press and how to slash' in order to achieve individual end state"⁹. The "ZERO ERROR SYNDROME" has given rise to an environment polluted by the stink of ethical abuse¹⁰. In the battlefield, such leaders will try to take the safer course which will lead to defeat rather than the riskier one, which will be essential for victory.

9. "Analysis of Existing Junior Leadership Environment in the Unit and Measures to Improve-Major (Retd) Kazi Atiqul Haque, Arty, Dissertation for MDS, Session 2009, DSCSC, Dhaka".

10. "Brigadier Sikander Shami, Pakistan Army, 'Targeting the Middle Leadership', Pakistan Army Green Book, 1991, pp- 24".

Suitable Leadership Style to Command Generation Z

Adjustment to be made by Military Leaders

A military commander should capitalize on the traits and take actions based on the situation he encounters. Following paragraphs shall discuss the adjustments to be made by BDAF leaders to successfully handle/ command and earn unquestionable loyalty from Gen-Z.

a. **Friendly Working Environment** : Friendly working environment may be defined as a fearless environment where subordinates can perform their jobs without fear of penalty and over supervision. “No matter what the level of competence and motivation is, without suitable friendly environment, the potentials of UCs are less likely to be harnessed”¹¹. Thus, they need support from their superiors to perform efficiently keeping their minds and bodies out of stress.

b. **Self-Improvement** : There is a saying, ‘Learn to obey first before you command’. A military commander can become a perfect leader through a series of transformation from the day he joins the service. He can achieve perfection by improving his leadership styles and traits. “Leaders need to be able to discover their own strengths and the strengths of those with whom they work”¹². They need to develop the skills to be flexible in order to exploit the changing situations.

c. **Keeping Gen-Z under Multiple Tasking** : “Gen-Zers are more proficient in multitasking than all previous generations. Studies prove that, Gen-Z will be even more capable of handling multiple things at once than generations before”¹³. Senior officers in their interview also advocated to

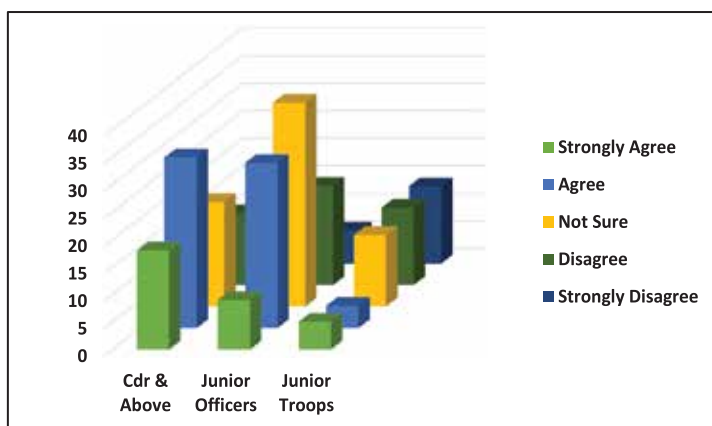
11. “Interview, Commandant, Bangladesh Naval Academy, Commodore (now Rear Admiral) Masud Iqbal, (C), NPP, psc, BN, over mobile phone. Interviewed on 12 June 2020”.

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13. “Pro Sky, Reasons to be excited about working with Generation Z!, 13 June 2020, <https://talkingtalent.prosky.co/articles/reasons-to-be-excited-about-working-with-generation-z#:~:text=Gen%20Z%20is%20more%20proficient,at%20once%20than%20generations%20before.&text=They%20will%20expect%20to%20multitask,enough%2C%20they%20may%20get%20bored.> Accessed on 13 June 2020”.

keep them under multiple tasking which will help them learn to encounter stressful and complex situations¹⁴.

Figure 6 : Opinion of Survey Participants on Keeping Gen-Z in BDAF Under Multiple Tasking



Source - Survey Conducted by the Author

d. Earning Professional Competency : Professional competency acts as a facilitator for correct decision making. To become a competent leader, a commander needs to focus on improving his professional competency. “Tactical commanders use combat power to accomplish missions. Operational commanders require experience at both operational and tactical levels. In strategic level, a leader should acquire the understanding of the operational planning and constraints to achieve the end state”¹⁵. In Information Warfare (IW) age, military leaders should have a thorough understanding of the dynamic OE to efficiently utilize available resources to achieve the desired end state. They should also have a broad knowledge

14. “Interview, Drafting Authority, Bangladesh Navy, Cdre Arif Ahmed Mustafa, (G), NUP, afwc, psc, BN, over mobile phone. Interviewed on 05 June 2020”.

15. “Operational Leadership- Commodore (now Rear Admiral) Mir Ershad Ali, (G), psc, BN, Bangladesh Navy Journal, Volume 1, November 2013”.

of political issues, diplomacy, international economy, geopolitics, social and other issues of importance in their respective theaters”¹⁶.

e. Motivating UCs Socially and Religiously : In Bangladeshi society, religious and social motivational lessons play important role in shaping up human character. On the contrary, “a major part of the society has gone corrupt, which also has an impact on military culture. Social ethics and values have deteriorated by which Gen-Z in military are being affected”¹⁷. However, it is believed that if Gen-Z in BDAF are socially/religiously motivated, many social crimes can be stopped in military services. Senior officers also emphasized on religious teachings¹⁸.

f. Assessing UCs on the Basis of Technical Skills : As Gen-Z is more technically oriented, while assessing them, their technical skills should be taken into consideration. “Nobody is useless, the leader is to find out the potentials of each UCs and delegate the right job to the right person”¹⁹. General George Patton said, “Never tell people how to do things. Tell them what to do and they will surprise you with their ingenuity.” If the potentials of Gen-Z can be utilized properly, fighting for BDAF in the IW age will not be a difficult task.

g. Demanding Job as per Responsibility Assigned : Gen-Z quest for justification of every action and on successful completion of an assignment, they aspire for recognition²⁰. Practical experience says that, in military,

16. “Operational Warfare at Sea- Milan Vego. Routledge Publishers, 2009, pp- 200”.

17. “Interview, Commanding Officer, BNS SOMUDRA JOY, Capt (now Commodore) Mohammed Asaduzzaman, (ND), psc, BN, over mobile phone. Interviewed on 12 June 2020”.

18. “Interview, Drafting Authority, Bangladesh Navy, Cdre Arif Ahmed Mustafa, (G), NUP, afwc, psc, BN, over mobile phone. Interviewed on 05 June 2020”.

19. “Interview, Commandant, Bangladesh Naval Academy, Commodore (now Rear Admiral) Masud Iqbal, (C), NPP, psc, BN, over mobile phone. Interviewed on 12 June 2020”.

20. “Interview, Psychologist Bangladesh Naval Academy, Cdr M Habibur Rahman Khan, (Edn), PhD, BN over mobile phone. Interviewed on 04 June 2020”.

Gen-Z are capable of undertaking assignments compatible with them and most of them are found very enthusiastic to accomplish given assignments. Eventually some good words of appreciation boost their morale significantly and accelerate their willingness to undertake more challenges.

Suitable Leadership Style to Command Gen-Z

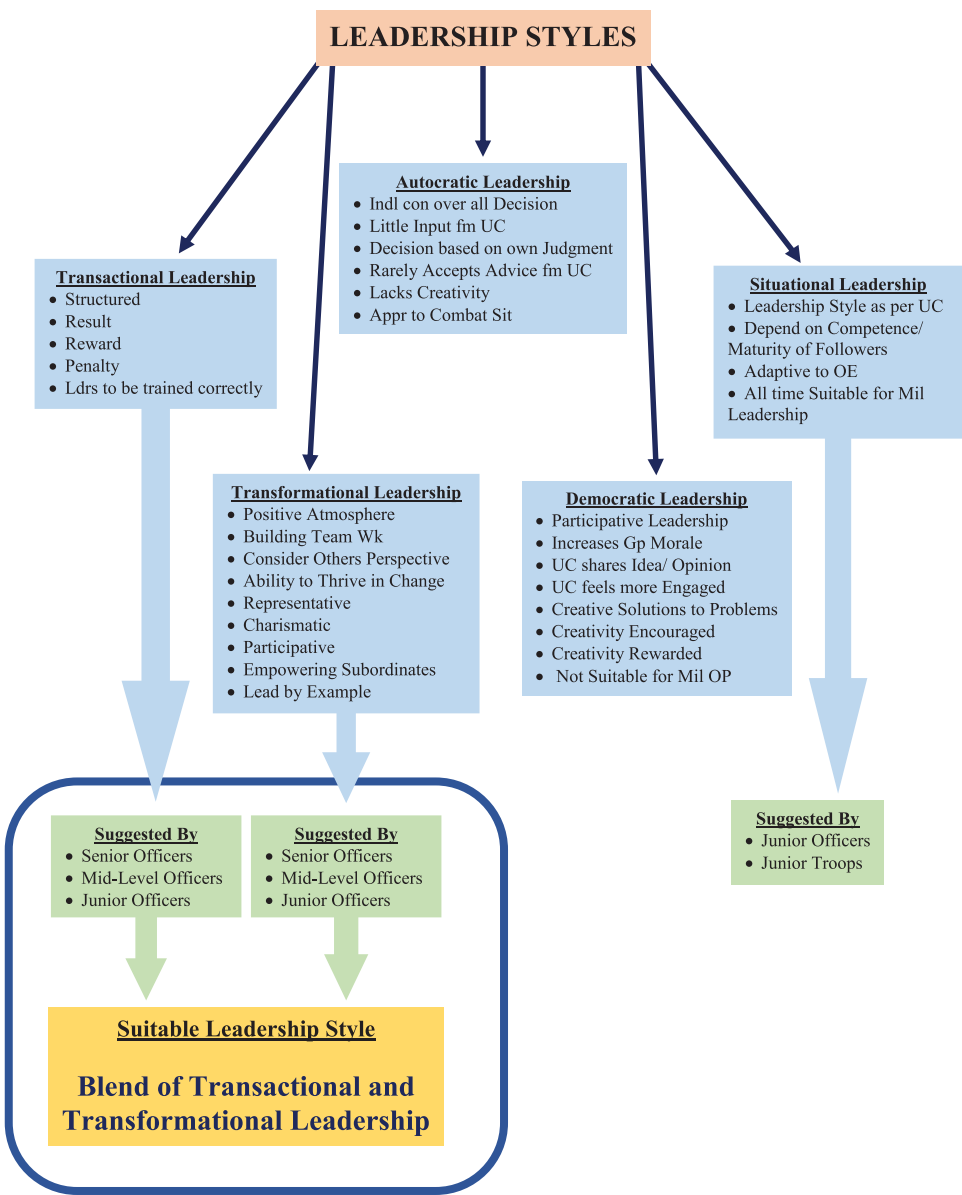
The overall study says that, Gen-Zers are little different from their predecessor generations due to the nature of their grooming. “Handling Gen-Z in this era largely depends on identification, orientation, and understanding their psyche. They are hyper-aware of ongoing issues and facts of the world. It is imperative that, in order to handle this cohort, authoritarian attitude needs to be modified with the changing view to be friendly, free from stereotypes, and flexible”²¹. While discussing the adjustment to be made by military leadership, it was revealed that adjustments need to be applied in many aspects to handle Gen-Z effectively to reap the best of their capability.

During an Focused Group Discussion, all the participants opined that, to command Gen-Z in this digital age, leaders must adjust their styles and they must apply a blend of different leadership styles to manipulate those as per prevailing situations. Most of them opined for blend of Transactional and Transformational style of leadership.²² Senior military officers also opined that, to command and reap the best out of Gen-Z, a combination of two or more style of leadership is required. They also recommended a combination of Transactional and Transformational Leadership which contains the characteristics of all other leadership styles.

21. “Ibid”.

22. “Online Focused Group Discussion on 05 June 2020 at 1930 hours. Participants were Lt Col Farid, Capt Mehdi, Cdr Farhad, Cdr Fahid, Cdr Ikram, Cdr Moin, Cdr Ariful, Cdr Arif and Gp Capt Alam”.

Figure 7 : Flow Chart- Suitable Leadership Style for Military Leadership
To Command Gen-Z in Digital Age



Conclusion

Military is an integrated service with multi-dimensions. In this digital age, BDAF require leaders who are knowledgeable, who can effectively work in hi-tech environment, yet still have the warfare expertise required of a military officer. Technology-driven Gen-Z are competitive, ambitious, industrious, and always on with changes in technology. They accept challenges sportingly and focus on their target. Even though the screen time addiction of Gen-Z in BDAF is seen positively and their talent can be utilized for the betterment of the services.

Handling Gen-Z in armed forces is not an easy task. Imposing rigorous, authoritative leadership on Gen-Z in armed forces may be challenging and jeopardous. Due to the two generation gap between present military leadership and Gen-Z, there remains a difference between ways of understanding, ability to think rationally, ideological believes, behavioural acceptance, social/ religious values.

In the digital age, the OE is much more complex. Today's warfare is equipment-oriented and none but the Gen-Zers are expected to be the best choice to handle the complexities of these equipment. The challenge lies in making youngsters fully capable of operating, maintaining and troubleshooting hi-tech military equipment. The performance of Gen-Zers in armed forces in many cases directs towards the achievement of personal objectives by whatever means. Again, a culture of taking no responsibility has also been developed. These indicate that the military leadership will face numerous challenges to command Gen-Z in the digital age.

Leader follower relationship is always a vital factor for successful leadership. Today's commanders should be adaptive, flexible and be ready to make adjustments in their leadership attributes with the changing situations. Presently, the most significant suggested adjustment is creating a friendly environment in units to get the best out of Gen-Z. The leaders should also motivate UCs on religious teachings so that the morale and ethical standard is

maintained. Basically, it will be the leaders' foresight to discover the individual potentials and assign tasks accordingly.

The paper made an endeavour to discuss different aspects of military leadership and its challenges to command Gen-Z in the digital age. It tried to focus the adjustments to be made by military leaders and suggested blending different leadership styles to command Gen-Z in BDAF. At the end it may be said that the combination of Transactional and Transformational Leadership contains the characteristics of all other leadership styles. If this style is adapted by a military leader to command Gen-Z in BDAF, he can reap the best out of them.

Recommendations

Leadership can be considered as an art or science or sometimes it is art and sometimes science. To efficiently command Gen-Z and effectively utilize them for the betterment of the services, the following are recommended:

- a. The present military leadership should understand the general personality profile of the members of the Gen-Z in the armed forces.
- b. A leader should find out the potentials of his UCs and delegate right job to the right person.
- c. To effectively command the Gen-Z, commanders may maintain a healthy working environment in their respective units.
- d. The extremely efficient Gen-Z may be given multi tasks at a time to prepare them to encounter stressful and complex situations of the OE.
- e. To effectively command Gen-Z and mitigate the challenges of the digital age, military commanders should adopt a balance between Transactional and Transformational style of military leadership.

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INTERNAL ARMED CONFLICT IN MYANMAR : TWO TURNING POINTS

Commodore Kutub Uddin Mohammad Amanat Ullah, (G), NUP, afwc, psc, BN

Abstract

Internal armed conflict in Myanmar has existed between ethnic Burman in Burma proper and non-Burman Frontier Areas for many decades. The non-Burman ethnic armed groups were fighting for regional autonomy as promised in the Panglong conference of 1947 for their security, economy and power, and for refraining from interference in each other's domestic affairs. The optimism of such regional autonomy under a federal constitution was eliminated by the 2008 constitution. However, the demand was reinvented after the military coup in 2021 and for the first time in history, the ethnic armed group was significantly successful in many regions against well-trained military Junta. The question arises, why the ethnic armed group was so successful after so much of long time? Thus, this article pursuit the answer and finds two prime turning points that differs from previous long enduring efforts. First, the conduct of 'Operation 1027' with the formation of the alliance amongst three ethnic armed groups maintaining operational security known as three brotherhood alliances; and second is the innovative use of drone technology in guerilla warfare that the opposition was not prepared for. Blending of these two issues focused on the common objective of withdrawing military government from power, while the success of 'Operation 1027' brought strategic momentum by instigating successful coordinated operations and drones worked as a game-changing technology showing a new way of gaining success in those operations. However, these two turning points do not necessarily cross out the importance of associated actions undertaken by many actors during the conflict.

Introduction

Internal armed conflicts in Myanmar have been prevalent for decades, involving various ethnic groups¹ and ideological factions across all of Myanmar's

1. Myanmar officially recognizes 135 ethnic races excluding Rohingya and many others. See Yukiko Nishikawa, *International Norms and Local Politics in Myanmar*, 1st ed. (London: Routledge, 2022), 26.

borderlands. It started with the diversity of rebel groups that emerged in the 1940s and 1950s as the ‘multi-colour insurgents’², engaged in power struggles in respective occupied territories. As the conflict continued, there was an initiation of peace efforts in 1960s, federal movement in 1961-62, peace talks in 1970, ceasefire agreement in 1990s and the Nationwide Ceasefire Agreement (NCA) in 2015 - none of which could bring a permanent solution for peace and stability. Meanwhile, many of the ethnic or religious groups were reformed time to time with new motivation of security concerns, economic resources, governmental power, or private interests³. The most dominating group was the ethnic Burman⁴ with majority of them served in Tatmadaw, leading the military and military-led government⁵ against other ethnic groups. While Tatmadaw tried to control non-Burman ethnic territory or state, the later battled hard, unwilling to compromise their foothold to what they considered occupying force⁶. Their struggle for autonomy continued with ethnic tension and grievances but no mentionable success was achieved. This social phenomenon⁷, for the first time in

2. It ranged from ethno-nationalist revolt by the Karen National Defence Organization, Arakan National Defence Force, Mon People Front to leftist insurgents of the white flag, Red Flag branches of the Communist Party of Burma, to the Muslim resistance Army of Arakan. See John Buchanan, “Militias in Myanmar” (Yangon: The Asia Foundation, 2016), 6.

3. Valère Philip Gagnon and V. P. Gagnon, *The Myth of Ethnic War: Serbia and Croatia in the 1990s*, 1. print., Cornell paperbacks, Cornell Paperbacks (Ithaca, NY: Cornell Univ. Press, 2006), 31–51.

4. Burman is a privileged identity refers to the majority ethnic group dominating the country that influences various aspects of the society. They receive institutional benefits and a sense of cultural and political dominance over non-Burmans. See Liyun Wendy Choo, “Of Citizens and Strangers: The Privilege of Being Burman,” *Compare: A Journal of Comparative and International Education* 53, no. 8 (November 17, 2023): 1429–46, <https://doi.org/10.1080/03057925.2022.2054774> and Matthew J. Walton, “The ‘Wages of Burman-Ness:’ Ethnicity and Burman Privilege in Contemporary Myanmar,” *Journal of Contemporary Asia* 43, no. 1 (February 2013): 1–27, <https://doi.org/10.1080/00472336.2012.730892>.

5. Other than the NLD, the Government in Myanmar is usually denoted as ‘Military Government’ or ‘Military led Government’ by various scholars. See Su-Ann Oh, *Myanmar’s Mountain and Maritime Borderscapes: Local Practices, Boundary-Making and Figured Worlds* (Singapore: ISEAS-Yusof Ishak Institute, 2016), 73; Nishikawa, *International Norms and Local Politics in Myanmar*, 7.

6. Nishikawa, *International Norms and Local Politics in Myanmar*, 4.

7. Internal Armed conflict is considered a social phenomenon as evidenced by the historical context of Burma’s post-independence period marked by ethnic insurgencies and deep societal divisions. See N. Ganesan et al., eds., *Myanmar: State, Society, and Ethnicity* (Singapore: Hiroshima, Japan: Institute of Southeast Asian Studies; Hiroshima Peace Institute, 2007). and Reshmi Banerjee, *Reflections on Myanmar: Identity, Heritage, Aspirations* (London New York: Routledge, 2023).

Myanmar history, took a new turn with the conduct of "Operation 1027" by three Brotherhood Alliances (3BHA)⁸ and brought strategic outcomes against the military-led central government. In addition, drones and counter-drone capabilities brought a radical change in norms and conduct of warfare. For the first time in Myanmar's history, the outcome of civil war showed greater success for rebel alliances than the existing military force.

Thus, this article highlights the formation of the alliance and its coordinated offensive as a strategic move, which was later supported by the game-changing technology of drone warfare. While highlighting, this article analyzes the origin of the armed conflict and its present momentum. It showcases the activities of Arakan Army (one of the three brotherhood alliances), which is operating adjacent to Bangladesh. The article also analyzes the evolution in drone warfare and its revolutionary use in Myanmar's internal armed conflict. It is important to note that the above-mentioned issues or turning points as highlighted by the author do not necessarily cross out the importance of associated actions undertaken by many actors during the armed conflict.

Origin of Myanmar Internal Armed Conflict

The origin of Myanmar's internal armed conflicts started with the formation of the Union of Myanmar for control of a 'subnational territory'⁹, or territory of different ethnic groups within the sovereign state. The broad division of its internal organization divided the country into Burma proper with ethnic Burman and non-Burman Frontier Areas. These non-Burman frontier areas had been the epicentre of decades-long civil war and gave birth to an enormous array of non-state armed groups. The reason for this long-decade conflict lies in the agreement made at the Panglong conference of 1947, where Gen Aung San,

8. Alliances of Myanmar National Democratic Alliance Army (MNDAA) in Kokang Self Administrative Zone of Shan State, Ta'ang National Liberation Army (TNLA) of Shan State and Arakan Army (AA) of Rakhine State.

9. The conflict in Myanmar is termed as 'subnational conflict' which is defined as the Armed Conflict over subnational territory within a sovereign state. See Adam Burke et al., "The Contested Areas of Myanmar - Subnational Conflict, Aid and Development" (The Asia Foundation, 2017), xiii.

the leader of the "thirty comrades"¹⁰ and subsequently, the head of ethnic Burman agreed upon equal treatment and power sharing and their regional autonomy under a federal constitution¹¹. These ethnic Armed states relied on the hope of autonomous regions refraining from interference in each other's domestic affairs and hoped to fulfil each other's ambitions through a general equilibrium of power. The desire for such "Westphalian peace,"¹² might apply to the modern independent states of the West but was too ambitious for non-Burmar frontier states.

The optimism of the regional autonomy by the non-state actor under a federal constitution was finally eliminated by the bindings of 2008 constitution under three main national causes: non-disintegration of the Union, non-disintegration of the national solidarity and the perpetuation of sovereignty.¹³ These three national causes, or meta-principles, are living manifestations of direct military rule.¹⁴ The first principle represents territorial unity of the military state, as if, the union is fully integrated, and denies ethnic groups' desires for independence and separatism.¹⁵ The second principle also has a negative connotation that national solidarity has already been achieved; the people and the nation are subject to the constitution and this solidarity can't be disintegrated¹⁶. The third principle focuses on defending state sovereignty against external interference.

10. Thirty comrades are the founders of the Burma Independence Army (BIA) in 1940 who acquired military training in Japan and China during WWII and took part in the Japanese invasion of Burma in 1942. These thirty ethnic Burmans were prominent nationalists and considered heroes in the history of contemporary Burma. They are also the genesis and the mainstream of the modern Tatmadaw. See Ardeth Maung Thawngmung, *The Karen Revolution in Burma: Diverse Voices, Uncertain Ends*, Policy Studies 45 (Singapore : Washington, D.C: Institute of Southeast Asian Studies ; East-West Center, 2008), 54.

11. David Brenner, *Rebel Politics: A Political Sociology of Armed Struggle in Myanmar's Borderlands* (Ithaca: Southeast Asia Program Publications, an imprint of Cornell University Press, 2019), 2.

12. Henry Kissinger, *World Order: Reflections on the Character of Nations and the Course of History* (London: Penguin Group, 2014), 10–11.

13. Melissa Crouch, *The Constitution of Myanmar - A Contextual Analysis*, First (Hart Publishing, 2019), 37.

14. *Ibid.*, 3.

15. *Ibid.*, 37.

16. *Ibid.*, 38.

Thus, Tatmadaw or Ethnic Burman made a planned vision of remaining in power of the nation including the non-Burman frontier states. As time went by, the dynamics of the conflict became complex, driven by compelling demands of control over resources, authority and territory.

Present Conflict: Two Turning Points

Resistance against the Myanmar Military Government or the SAC (State Administrative Council) by the Ethnic Armed Groups, which have been fighting for autonomy for decades, was reinvented after the military coup since 2021. With the People's Defence Force (PDF), formed in 2021 by pro-democracy activists and the National Unity Government (NUG) in exile,¹⁷ the Ethnic Armed Group also started to refuse the authority of Tatmadaw and sided with the people¹⁸, what they call a “spring revolution” against the military. Two distinguished issues made this resistance a new turn. First, the conduct of ‘Operation 1027’ with the formation of the alliance amongst the Myanmar National Democratic Alliance Army (MNDAA)¹⁹, Ta'ang National Liberation Army (TNLA), and Arakan Army (AA), which banded together under the banner of the three Brotherhood Alliance (3BHA)²⁰. This coordinated major operation brought radical momentum to the overall campaign and operational success for 3BHA. The second turning point is the extensive use of drones and the revolution in drone technology by the resistance force, specifically the use of commercial agricultural drone²¹ for scouting and combating guerilla warfare. These two turning

17. Mohammad Tanzimuddin Khan, “Dealing with Myanmar’s Civil War Requires Delicate Deliberation,” *The Daily Star*, February 14, 2024, <https://www.thedailystar.net/opinion/views/news/dealing-myanmar-civil-war-requires-delicate-deliberation-3543511>.

18. Chosein Yamahata, Bobby Anderson, and Palgrave Macmillan (Firm), eds., *Demystifying Myanmar’s Transition and Political Crisis* (Singapore: Palgrave Macmillan, 2021), 215.

19. MNDAA was formed by a 3000 strong force when the insurgent Communist Party of Burma (CPB) collapsed in 1989. see Andrew Selth, *Secrets and Power in Myanmar: Intelligence and the Fall of General Khin Nyunt* (Singapore: ISEAS-Yusof Ishak Institute, 2019), 153.

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21. Hannah Beech, Paul Mozur, and Adam Ferguson, “Drones Changed This Civil War, and Linked Rebels to the World,” *The New York Times*, May 4, 2024, sec. World, <https://www.nytimes.com/2024/05/04/world/asia/myanmar-war-drones.html>.

points together, focused on the common objective of withdrawing military government from power, while the success of ‘Operation 1027’ brought strategic momentum by instigating successful coordinated operations and drones worked as a game-changing technology showing a new way of gaining success in those operations.

First Turning Point: Outcome of Alliance Spirit in Rakhine State

The conduct of "Operation 1027" by 3BHA was the most unpredictable campaign that sparked a significant offensive capturing an area equivalent in size same as Belgium²². It was conducted simultaneously in multiple parts maintaining operational secrecy where the movement of troops and materiel was conducted over a long period²³ and in a generic way that Myanmar intelligence failed to understand such coordinated efforts²⁴. Secrecy was maintained by passing the information to the specified people on need-to-know basis within the inner circle²⁵. The attacks were conducted on vulnerable units by surrounding them from all sides and keeping an exit way for them to leave. In fact, the ethnic armed group was preparing for a long time and waiting for opportunities to utilize it.

The strategic implications of ‘Operation 1027’ by 3BHA can be well understood from the outburst of military operations “opening a new front”²⁶ throughout Myanmar. Initiation of several military operations by rebel forces such as Operation 1107 and 1111 in Kayah state, Operation 0307 in Kachin State²⁷ etc is the inspirational outcome of the initial operation. In consequence to these offensives, the Myanmar military lost major base locations in strategically

22. David Brenner, “Misunderstanding Myanmar through the Lens of Democracy,” *International Affairs* 100, no. 2 (March 4, 2024): 766, <https://doi.org/10.1093/ia/iaae015>.

23 David Scott Mathieson, “Putting Myanmar’s 1027 in Realist Perspective,” *Asia Times*, July 1, 2024, <http://asiatimes.com/2024/07/putting-myanmars-1027-in-realist-perspective/>.

24. “Operation 1027: Time to Broker a Peace Deal in Myanmar | Hc:63245 | Humanities CORE,” accessed August 4, 2024, <https://hcommons.org/deposits/item/hc:63245/>.

25. Mathieson, “Putting Myanmar’s 1027 in Realist Perspective.”

26. Morten B Pedersen, “Outrage Is Not a Policy: Coming to Terms with Myanmar’s Fragmented State,” May 12, 2024, 11.

27. Mathieson, “Putting Myanmar’s 1027 in Realist Perspective.”

crucial Paletwa in neighbouring Chin State as well as key central townships such as Mrauk U in Rakhine State, the symbolic capital of the former Kingdom of Arakan. They also lost the Headquarters of Northern Regional Military Command in Lashio in Northern Shan State²⁸.

Among the three alliances, the Arakan Army seized much of the territory from the China border to the North-Western territory of Mandalay by Blitzkrieg operation against the Myanmar Military at the beginning²⁹. Gradually it shifted focus on the Western front close to Bangladesh border and synchronized its further offensive. The operations by AA in Rakhine state are the nation's largest de facto state-ethnic nationality armed movement. In July 2024, AA offensives were conducted in three major military theatres of Rakhine State: Maungdaw township in northern Rakhine, Ann township in the centre, and Thandwe township in the south³⁰. On the other hand, Myanmar military also conducted joint or combined operations with a combination of naval bombardment, air strikes, artillery barrages but finally had to leave the area³¹. As the AA gained control of Southern Rakhine State, the Myanmar Army Western Command Headquarters in Ann Township became increasingly exposed³². The capture of a huge number of towns, military bases, Military Operations Commands, the capture of the Thandwe airport, drone attack on Maung Shwe Lay Naval Base³³ and most importantly fall of the operational momentum of the Myanmar Military are the mentionable outcomes of the war^{34 35}. Despite the far-reaching consequences of these actions, due to fast administrative expansion and ambiguous

28. "Myanmar Armed Group Says Captured Regional Military Command," Dhaka Tribune, accessed August 5, 2024, <https://www.dhakatribune.com/world/asia/353573/myanmar-armed-group-says-captured-regional>.

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30. Ibid.

31. "Regime Collapse in Myanmar's Rakhine | Lowy Institute."

32. Ibid.

33. Raung Ni, "Myanmar Junta Defending Last Naval Base in Rakhine State's Thandwe Township," Myanmar Now, July 25, 2024, <https://myanmar-now.org/en/news/myanmar-junta-defending-last-naval-base-in-rakhine-states-thandwe-township/>.

34. Mathieson, "Putting Myanmar's 1027 in Realist Perspective."

35. "Regime Collapse in Myanmar's Rakhine | Lowy Institute."

territorial borders, these actions, due to fast administrative expansion and ambiguous territorial borders, it's hard to tell precisely how much area the Arakan Army controlled. However, it appears they had de facto power over 50 to 75 per cent of Rakhine State till July 2024³⁶.

2nd Turning Point: Use of Drone in Asymmetric Warfare: A Game-Changing Technology

The use of drones against ethnic armed groups was one of the strongest means of warfare in support of military operations by the Myanmar military. They extensively used Chinese-supplied weaponized CH2, CH3 drones^{37 38}, first-person view of CH4 drones with sophisticated cameras³⁹, Sky-02A⁴⁰ and Skylark-I-LEX manufactured by Israel⁴¹. Other than Chinese and Israeli drones, Myanmar became the first export destination for Russia's Orlan-10E Surveillance drone⁴². Moreover, in 2021, Myanmar received Camcopter S-100 UAVs from Schievel Corporation via a Russian partner OAO Gorizont for the Myanmar Navy⁴³.

36. Ibid.

37. David Scott Mathieson, "The Arakan Army in Myanmar: Deadly Conflict Rises in Rakhine State" (US Institute of Peace, 2020), 10, <https://www.jstor.org/stable/resrep27590>.

38. Selth, *Secrets and Power in Myanmar*, 137.

39. "Myanmar Military Adds Advanced Chinese Drones to Arsenal," Radio Free Asia, accessed July 12, 2024, <https://www.rfa.org/english/news/myanmar/military-junta-china-drones-05142024134227.html>.

40. Selth, *Secrets and Power in Myanmar*, 136.

41. "An Israel-Made Drone Is Seized by Arakan Army and Arrested 3 Family Members of Myanmar Army While Looking for the Drone," accessed July 13, 2024, <https://arakan.news/2020/06/an-israel-made-drone-is-seized-by.html>.

42. Myanmar Becomes the First Export Destination for Russia's Orlan-E Drone!, 2021, <https://www.youtube.com/watch?v=Hvj4ohsFP74>. In January 2021 Russia agreed to supply Myanmar with surveillance drones along with Pantsir-S1 Surface to Air Missile System and Radar equipment. Also See Yamahata, Anderson, and Palgrave Macmillan (Firm), *Demystifying Myanmar's Transition and Political Crisis*, 217.

43. "Myanmar Military Arms Broker Supplied UAV Parts from Austria since Coup Attempt | Justice For Myanmar," accessed July 13, 2024, <https://www.justiceformyanmar.org/stories/myanmar-military-arms-broker-supplied-uav-parts-from-austria-since-coup-attempt>.

On the other hand, after 2021 military coup, the anti-resistance force specifically the PDF introduced the “Wings of the Irrawaddy,”⁴⁴ to attack the Myanmar Army from a long distance⁴⁵. The three drone units of rebel groups carried out a total of 642 drone attacks in the Sagaing and Magway regions in 2023⁴⁶. Thereafter, the technology shifted to other rebel groups and they conducted more than a hundred flights per month in all conflicting areas including the Rakhine state⁴⁷. Arakan Army used both combat and patrol drones with six propellers and could carry heavier loads⁴⁸. These drones were mostly commercial drones used for spraying chemicals in agriculture⁴⁹, could scout at night, equipped with 2-5 bombs, operated with less manpower and became a nightmare for the country's better-equipped military⁵⁰. The main difference between the commercial drones and the locally made improvised military drones were the triggering part, which needed technical know-how⁵¹. The students who joined the rebel groups took the basic knowledge by buying one or two drones and later made these drones using 3D printers⁵². The success of these new creations was so evident that each of the major armed resistance groups introduced a new department to fight drone warfare which included drone improvising, repair and recycling. “The drone department consists of skilled young fighters – some of whom were engineering students and some gained knowledge of drones as a hobby.”⁵³

44. “2 Years after Coup, Drones Turning the Tide for Myanmar’s Armed Resistance,” Radio Free Asia, accessed June 20, 2024, <https://www.rfa.org/english/news/myanmar/drones-01252023173803.html>.

45. “In Myanmar, Fight between Rebels and Military Heralds Drone Wars in the East,” Firstpost, February 13, 2023, <https://www.firstpost.com/opinion/in-myanmar-fight-between-rebels-and-military-heralds-drone-wars-in-the-east-12146692.html>.

46. “2 Years after Coup, Drones Turning the Tide for Myanmar’s Armed Resistance.”

47. Beech, Mozur, and Ferguson, “Drones Changed This Civil War, and Linked Rebels to the World.”

48. “Drones Level Playing Field for Myanmar’s Armed Opposition against Powerful Military,” Radio Free Asia, accessed June 20, 2024, <https://www.rfa.org/english/news/myanmar/drones-09242022111201.html>.

49. Ibid.

50. Ibid.

51. Ibid.

52. Beech, Mozur, and Ferguson, “Drones Changed This Civil War, and Linked Rebels to the World.”

53. Aakash Hassan and Hannah Ellis-Petersen, “‘We Killed Many ... Drones Are Our Air Force’: Myanmar’s Rebels Take on the Junta from above,” The Observer, January 20, 2024, sec. World news, <https://www.theguardian.com/world/2024/jan/20/myanmar-rebels-junta-above-drones>.

A few units consisted of females, who made bombs, mixing TNT and aluminium powder, then layered metal balls and gunpowder around the volatile core.⁵⁴ For rebel groups, instead of cooking, they became the front-line fighters in drone warfare. During the battles, these drones proved to be efficient, precise, safe, and labour-light.⁵⁵ To counter these drones, the Junta military used radio frequency jammers near their bases.⁵⁶ Russian-made jammers were also known to be used that take out drones by blocking their signals.⁵⁷ Besides, anti-drone guns had been installed in strategic locations to protect the bases and installations from drone attacks.⁵⁸

Lessons and Concerns

This internal conflict proved to be a classic example of the collapse of the part of a regime ruled by well-trained Armed Forces.⁵⁹ Operation 1027 highlighted five positive and four cautionary lessons, one being common in both cases. The **first** lesson is operational security and thereby achievement of surprise in launching any operation, keeping the attack plan on a "need to know" basis. The **second** lesson is the power of effective alliance building and phasing of the operation and logistics. Mentionable that, 3BHA were preparing almost for five years for such large-scale operations and was able to carry out attacks on the strategic points, in a collective, surprised, and synchronized manner. The history revealed that 3HBA staged a mini 1027 in 2019 with an accurate force structure and logistics – that reflect a strategic maturity.⁶⁰ The **third** lesson was to give the enemy an option. The cordon of the enemy force by AA was well planned and executed with an exit route to allow the military to leave bases. The **fourth** lesson is plain serendipity that luck is where the preparation meets opportunity.

54. Beech, Mozur, and Ferguson, "Drones Changed This Civil War, and Linked Rebels to the World."

55. "2 Years after Coup, Drones Turning the Tide for Myanmar's Armed Resistance."

56. "Drones Level Playing Field for Myanmar's Armed Opposition against Powerful Military."

57. Beech, Mozur, and Ferguson, "Drones Changed This Civil War, and Linked Rebels to the World."

58. "Drones Level Playing Field for Myanmar's Armed Opposition against Powerful Military."

59. "Regime Collapse in Myanmar's Rakhine | Lowy Institute."

60. Mathieson, "Putting Myanmar's 1027 in Realist Perspective."

The **fifth** lesson is the importance of the acceptance of changing dynamics of the war with technology or any other innovation, in which, the use of drones was reinvented as the game-changing technology in Myanmar's internal conflict.

There are four major concerns for the regional countries in relation to this conflict: **One**, gaining strategic culture of living with the conflict, disrupting the peaceful environment and changing the mindset of the people of bordering areas. **Two**, the devastating asymmetry in the firepower vis-a-vis the attack by Myanmar military forces and its strategic culture of ruthlessness in exploiting the armed advantages. **Three**, improving the military sustenance capabilities of Myanmar maritime forces and threatening the freedom of manoeuvre of others in and around international border lines in the Naaf River and adjacent areas. **Fourth**, bringing a revolution in drone technology through competitive use amongst military and Ethnic Armed Groups and thereby generating drone warfare capabilities of Myanmar as a future means of warfare.

Conclusion

Myanmar has a historical legacy of ethnic armed conflict for power sharing, equal treatment and regional autonomy. In the wake of their struggle, the ethnic armed groups brought remarkable success through three brotherhood alliances and 'Operation 1027' against the military Junta. This operation showed strategic consequence of initiating many other operations and brought desired success in different regions of the country. At the tactical level, a revolution in drone warfare and its innovative use served as the game-changing means and methods of warfare. The combination of innovative game-changing technology, the inspiration from the success of alliance-building and its spillover affects brought strategic momentum throughout the country in favour of ethnic armed groups against military Junta.

The internal conflict in Myanmar affected the border areas of regional countries and changed the strategic environment by disrupting social life with atrocities. The battle has changed the character of the Myanmar military by being in fighting for a prolonged period. Its experience in joint operations, sustenance,

and dealing with the changing dynamics of modern technology exceeds the quantum that Bangladesh military forces are yet to experience. Especially the advanced drone and counter-drone technology brought a strategic culture of fighting with the drone. Such drone force was an effective substitute for air power. The so-called unconventional warfare of the nineteenth century has turned into a new form of high-tech guerrilla force to accomplish the military objective of the state or entity. Besides, the combat logistic chain for drone improvising, repair and recycling facilities throughout Myanmar and the experience gathered by the whole country will remain the powerful instrument for any external crisis in future. How this game-changing technology can quickly be adopted, and training or experience can be attained by Bangladesh Military, remains as one of the primary challenges for ensuring nation's security in future.

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Biography of the Writer



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Commodore Amanat received couple of Letters of Appreciation and Award for his contribution operational level planning and research respectively. Later, he was also awarded with Nau Utkarsha Padak for his outstanding contribution in professional discourse. He is married and blessed with a son. Presently, he is serving as the Director of Naval Plans at Naval Headquarters.

BANGLADESH FORCE MARINE UNIT : PROMOTING PEACE, STABILITY AND SECURITY IN SOUTH SUDAN UNDER BLUE HELMET

Captain Md Zahirul Haque, (C), BCGM, BCGMS, psc, BN

Abstract

South Sudan, the youngest country in the world, gained its independence on 09 July 2011. Following its independence, the United Nations Mission in South Sudan (UNMISS) was established on 09 July 2011 to support the newest country in various fields, which includes assisting the new government with nation-building, protecting civilians, supporting humanitarian assistance, monitoring and investigating human rights violation and promote the implementation of the peace agreement. Currently, UNMISS is playing an important role in promoting sustainable peace, stability and protection to the civilians in South Sudan. Bangladesh Force Marine Unit started its journey in South Sudan on 12 April 2015. The unit is working hard to maintain pace with the increasing demand of the UN. The presence of the Bangladesh Force Marine Unit provides UNMISS with operational flexibility and options for addressing logistic challenges in the most economical and reliable means of transportation, especially to the northern volatile states. Despite various challenges, the unit earned a high reputation and is considered one of the esteemed units of UNMISS due to its sound professionalism and unwavering support to establish the UNMISS mandate. The contribution and commitment of Bangladeshi peacekeepers to the UN mission is widely recognized and appreciated. Bangladesh Force Marine Unit is doing its best to uphold this hard-earned recognition and is determined to work harder to create a peaceful and secure world, and prosperous South Sudan.

Introduction

South Sudan, the youngest country in the world gained its independence on 09 July 2011. The country covers an area of 644,329 sq km and is landlocked. The River Nile runs from South to North and is a lifeline for the country. The River Nile basin crisscrossed around 97.5 percent of the country and is divided into three main sub-basins that feed into the River Nile: The Bahr Al Jabal, Sobat, and Bahr el Ghazal¹⁰.

The length of the river route is 6795 km, and the navigable route is approximately 1936 km¹⁶. The country has one of the world's most underdeveloped road networks⁹. It has around 20,000 km of roads/track, but only 400 km is paved roads⁸. Just after the independence, the United Nations Mission in South Sudan (UNMISS) was established on 09 July 2011 to support the newest country in various fields, which includes assisting the new government with nation-building, protecting civilians, supporting humanitarian activities, monitoring and investigating human rights violation and promote the implementation of the peace agreement¹. UNMISS is the most challenging peacekeeping mission among all contemporary UN missions⁴. According to the Security Council, the present situation in South Sudan continues to pose a threat to peace and security in the region.

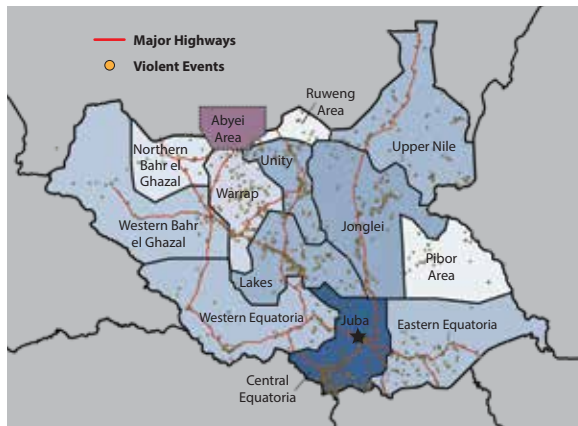
UNMISS has a high dependency on the River Nile for its sustenance in the northern part of the mission area because of the fragile road conditions of the country. A logistic convoy transports the logistics supply to the north part of the mission area through the river route under 'Operation Lifeline'. Bangladesh Force Marine Unit (BANFMU) provides Force Protection to this convoy. Besides, BANFMU also conducts various types of river patrol, recce, Search and Rescue operations, etc. BANFMU faces numerous challenges including security threats, machinery breakdown, and navigational hazards in performing these duties. BANFMU could negotiate all those challenges with their high professionalism and popularity among the stakeholders of the White Nile River. However, the present capability/resources of BANFMU may be increased to cover the vast Area of Responsibility (AoR) to support UNMISS's revised mandate for lasting peace.

About South Sudan

The Republic of South Sudan is a landlocked country. The country is termed as 'the land of great abundance', announced its existence as an independent country on 09 July 2011³. It gained independence from Sudan after two civil wars (1955-1972 and 1983-2005) and a six-year peace process through a referendum². It was unusual that South Sudan gained its independent sovereign status with a

peacekeeping mission mandated under Chapter VII of the UN charter on its territory by its invitation. The country shares its borders with Ethiopia to the east, Kenya to the southeast, Uganda to the south, the Central African Republic to the west, and Sudan to the north. It has a land area of 6,44,329 sq km, which ranked it the 44th largest country in the world¹². Juba is the capital of the country, which is also the fastest-growing city in Africa². The road network of the country is fragile. The River White Nile is the main geographical feature of the country. Around 1,00,000 sq km of her area is swampy¹¹.

Figure 1: Road Network of South Sudan



Source: <https://africacenter.org/spotlight/10-years-after-independence-south-sudan-faces-persistent-crisis>

The country is home to a diverse array of mainly Nilotic ethno-linguistic groups¹⁴. According to the population estimation survey in 2023, the country has 1,21,18,379 populations. The populations comprised 20 ethnic groups like Dinka, Nuer, Shilluk, Azande, Bari, Kakwa, Kuku, Murle, Mandari, Didinga, Ndogo, Bviri, Lundi, Anuak, Bongo, Lango, Dungotona, Acholi, Baka, Fertit¹⁴. Among the groups, Dinka, the tallest and the darkest-skinned people in the world, is the largest ethnic group, which counts approximately 35-40% of the total population². With 15% of the total population, Nuer is the second largest ethnic group in the country (2011)¹⁴. The official language of the country is English. However, a wide

variety of ethnic languages dominates the country. Besides ethnic languages, people also speak Juba-variant Arabic. The country has natural resources like hydropower, fertile agricultural land, petroleum, gold, diamond, limestone, iron ore, copper, chromium ore, zinc, tungsten mica, silver, hardwoods, etc¹⁷.

Understanding UNMISS

The United Nations Mission in South Sudan (UNMISS) has its origin in the unexpected termination of the UNMIS in July 2011⁴, when South Sudan became an independent country from Sudan¹. The mission came into existence on 09 July 2011¹. Beside land connectivity, due to fragile road conditions, UNMISS was forced to utilize the White Nile River as a transportation and logistics supply route for logistics items and humanitarian stores. Subsequently, the logistic operation 'Operation Lifeline' (OpLL), which plies along the River Nile came into existence. The UN Security Council termed the UNMISS as a complex multi-dimensional mission, and its inaugural mandate was to support the establishment of the new state and help solidify the foundation for sustainable peace. However, the mission could not proceed further with this mandate¹. Later, the UN Security Council revised the mandate based on the requirement. During its journey, UNMISS faced a few challenges like inter-tribal clash in Jonglei State in 2011, civil war in 2013 & 2016 and violations of SOFA¹. Currently, UNMISS is the second largest peacekeeping mission of the UN, which counts around 64 countries and approximately 17,954 personnel. With 1630 troops, Bangladesh is the fourth largest Troops Contributing Country in UNMISS³. The mission operates under Chapter VII of the Charter of the United Nations. The Mission's present mandate includes¹:

- a. Protection of civilians.
- b. Creating conditions conducive to the delivery of humanitarian assistance.
- c. Supporting the implementation of the revitalized agreement and the peace process.
- d. Monitoring, investigating, and reporting on violations of humanitarian and human rights law.

Function of BANFMU

BANFMU started its journey on 12 April 2015. Before joining BANFMU, UNMISS's land units used to provide force protection to OpLL. However, UNMISS faced difficulties in continuing the operation in support of a land unit along the river route and felt the necessity to deploy a specialist marine unit with equipment and boats to continue the operation. On 24 April 2014, while traveling through the Nile River, four barges carrying vital UN supplies came under small arms fire near the town of Tonga. Four crew members and UNMISS peacekeepers were wounded during that incident, and the barge sank. In the aftermath of this incident, the first rotation of the BANFMU comprised of personnel trained in diving, salvage, and special warfare joined the UNMISS and took over the force protection duties for UN barges plying through the River White Nile in early 2015. The AOR of UNMISS is the territorial land and waterways of South Sudan. Among 31 units of UNMISS, BANFMU is the lone marine unit responsible for these long waterways. The unit has 200 personnel, 12 boats, and other self-sustained equipment. Based on the State of Unit Requirement (SUR) and other relevant orders, there are 2-types of tasks for BANFMU:

a. **Primary Tasks** : BANFMU undertakes the following main tasks as per the concept of employment:

- (1) Provide FP to 'Operation Lifeline' to have secured movement of UN supplies, equipment, and personnel through the river routes.
- (2) Collect and report any intelligence that would support the transit of the barges and current operations of the Force.
- (3) Conduct medical evacuation for the assigned protection teams when other assets are unavailable or unsuitable.
- (4) Conduct Riverine Route Reconnaissance.
- (5) Conduct Riverine Patrols.
- (6) Protect designated ports used by the UN.
- (7) Provide Fire support to ground forces.
- (8) Transportation of UN personnel.

b. **Secondary Tasks :** Besides the primary tasks, BANFMU carries out the following supplementary tasks as well:

- (1) Assist with limited logistic resupply without the dependency on contracted civilian vessels.
- (2) Conduct SAR op to assist any person or vessel in distress within the AOR.
- (3) Provide riverine transportation to the other UN pillars by priorities set by the UNMISS FHQ.
- (4) Conduct Integrated Patrols along with other units.
- (5) Conduct Casualty Evacuation.
- (6) Conduct Diving Operations.
- (7) CIMIC activities.

Figure 3 : Rivers of South Sudan



Source : <https://blogs.lse.ac.uk/internationaldevelopment/2015/12/03>

Geography and Environment of AOR

The geography and environment of the AOR of BANFMU along the river route are described below :

- a. **Terrain :** The route of 'Operation Lifeline' along the River White Nile, is banked by marshy areas and open uninhabited bushland. Wooded and grassy lands are prominent, and most of the areas do not have suitable road connectivity.

b. **Depth** : The average depth of the White Nile River is barely workable for barge movement. In the dry season, the water reduces significantly, and frequent grounding is experienced en route. The river route has never been surveyed systematically or charted to assess the rate of seasonal depth change or to determine a safe navigational passage.

c. **River Navigation** : The distance of the route from MANGALLA to Renk via MALAKAL is 1300 km, and the river is not marked with any Navigational aids. Riverbanks often can't be differentiated from marsh. The width of the river varies from 100 meters to 250 meters. Barge masters are quite experienced, and the convoy solely depends on the barge master's navigation capability. However, incidents of entering through the wrong channel have been experienced. BANFMU had to guide the masters to follow the safe passage.

d. **Choke Points** : There are several sharp bends and dense vegetation, so visibility is sometimes less than a kilometer. Potential ambush points are available throughout the passage for both shoulder-carried and vehicle-mounted weapons.

e. **Human Habitation** : There are scanty human habitations along the river passage of the White Nile.

Operation Conducted by BANFMU

The unit conducts the following operations under CONOPS, Mission OPLANs and ROEs:

a. **Operation Lifeline (OpLL)** : Operation Lifeline is the UN logistic operation, where a logistic convoy moves from MANGALLA to the Northern part of the country. The main effort of BANFMU is to ensure the safety and security of this UN logistic convoy during her movement (MANGALLA – MALAKAL-Renk) to face the unpredictable security situation along the route. Sector North and Sector Unity depend on this logistic supply.

b. **Short Duration River Patrol (SDRP)** : A Patrol is conducted by Boats or Barges where the main objectives are to collect data, conduct recce, patrol or verify the situation in AOR. The duration of patrol does not exceed 48 hours.

c. **Integrated River Patrol (IRP)** : The IRP is classified as Military Integrated Patrols. It includes BANFMU and other elements from the Troops Contributing Country (TCC) or/and United Nations Military Observer (UNMO) with civilian agencies. It mainly facilitates the activities of other UNMISS pillars and other UN agencies that are not a part of UNMISS.

d. **Long Duration River Patrol (LDRP)** : Patrols are conducted out of towns/ports and villages by vessel/boat where no operating bases are present and the duration is more than 48 hours. The LDRP could be conducted solely by BANFMU or Integrated.

Figure 4 : Logistics Convoy on the River White Nile



Source : BANFMU-8 Click in 2023

Other Operational Activities Conducted by BANFMU

BANFMU also conducts the following operational activities in addition to the above-mentioned operations:

a. **FP to Humanitarian Agencies** : Often, BANFMU is deployed to provide FP for various humanitarian agencies like WFP, OCHA, FAO, INGOs, etc. In case of any emergency raised on the River White Nile, BANFMU is called for

rescue operation by UNMISS. BANFMU could accomplish many rescue Ops in a very professional manner without any causality, accident, or loss or damage of property.

b. River Route Recce Operations : The road connectivity in South Sudan is not good, and most of the areas do not have suitable road connections. Moreover, the current roads become unusable in the rainy season due to the topographical conditions. For this reason, UNMISS relies on river routes deeply for carrying logistics. UNMISS is planning for the logistics supply in the Unity State through the river route as it is a season-reliable route. It has been planned to extend the riverine op area up to NASSER to support the TOBs of the land unit. BANFMU carried out route recce up to MANGA Port and NASSER Port to execute the plan.

c. Diving Operations : BANFMU can conduct diving op in the White Nile. BANFMU provides diving assistance to the UN or local authority based on requirements.

d. Search and Rescue (SAR) Operations : BANFMU provides riverine SAR and Salvage Operations on the River White Nile and its tributaries. It is mentionable that BANFMU is the only capable unit to perform these activities in UNMISS.

e. Surveillance Support : The LPCs of BANFMU are equipped with RADAR to conduct surveillance along the river route. This surveillance helps to get early warnings and monitor the movements of other watercraft.

f. CASEVAC : BANFMU always remains prepared to carry out CASEVAC.

CIMIC and Other Activities Conducted by BANFMU

Medical Support under Civil-Military Cooperation (CIMIC) : BANFMU has no CIMIC responsibilities. Yet, both the subunits of BANFMU carry out plenty of medical campaigns to provide necessary medical support and treatment to the local people. Even the detachment deployed for the OpLL convoy provides medicine and medical support to the distressed people of remote areas en route where no medical facilities are available.

Joint Technical Working Group on the Nile River : The Joint Technical Working Group (JTWG) on River Nile Access, comprising the Govt of South Sudan, UNMISS, and representatives of humanitarian groups to discuss mechanisms to protect the rivers' utility and accessibility and to enable unhindered access for all stakeholders. The main aim of this high-level joint committee is to ensure Freedom of Movement for UNMISS as well as all South Sudanese people on the River White Nile. BANFMU being an operator on the White Nile River for a prolonged period, played a vital role in preparing a viable work plan to bring this dream into reality.

Role in IDP Management during Crisis : BANFMU has an important role in managing IDP during the crisis. The unit has the specific responsibility of IDP management inside the UN camp and guarding various sentry posts in aid of land contingents. The unit conducts regular training and participates in various exercises emphasizing synchronized and coordinated actions by all participants in different security scenarios.

Winching Training : To practice the emergency rescue operation on board OpLL barges, BANFMU conducts winching training and practical exercises in coordination with Sector HQ and other concerned specialized units.

Challenges Faced

While conducting operations in vast AOR, BANFMU faces numerous challenges to achieve the optimum goal. Some of the challenges faced by BANFMU in the mission area are mentioned below:

- a. **Complex Operating Environment :** The operating environment along the White Nile is very complicated. Govt & opposition forces have set up their military bases along the river equipped with heavy artillery guns, RPGs, machine guns, etc. Sometimes, they demand foodstuff and fuel displaying their might by firing warning shots and other coercive measures.

b. Volatile Political Situations leading to Non-compliance of UN Freedom of Movement : Govt and opposition party agreed on a peace deal. However, political stability is still a nightmare in South Sudan⁶. Both parties are subdivided into various groups further, and they barely follow the orders from the central leadership. BANFMU needs to negotiate with all the armed groups en route for conducting operations.

c. Inspection of UN Logistic Convoy by Both the Parties : Since the White Nile River is being used as a common Lifeline for both govt and opposition, any movement of barges and LPCs is speculated to be the movement of opposition. Barges are often stopped at numerous checkpoints en route for surgical inspection by both parties, which causes unnecessary delays and obstacles to the Barge operations.

d. Barges are Vulnerable to Armed Attack : Convoy barges are very vulnerable to armed attack. Barges loaded with highly flammable fuel are like bombs. Moreover, the slow speed makes the barge an easy target to attack.

e. Command and Control Issues of Govt and Opposition Forces : Govt and Opposition forces have poor command and control in most of their areas. Sometimes, clearances obtained from the higher echelon are not passed to the ground or the local Check Post Commanders in time thus they do not show respect to movement approval issued by govt.

f. Operational Mobility : There is a distinct mismatch in LPC and barge speed (70 km/h and 6-8km/h respectively). The LPCs face the problem of speed underway all the time with the barges at slow speeds.

g. Maintenance Challenge of LPCs : It is challenging to maintain these high-speed sophisticated LPCs after two subsequent barge protection trips. Moreover, spares and technicians are not available locally for LPC maintenance.

h. Uncharted/Un-surveyed River Route : BANFMU force protection team has to ply through the uncharted shallow White Nile River. OpLL barges have many grounding incidents, especially, in the dry season when water depth is minimal.

Future Augment Opportunities for BANFMU : The future augment opportunities for BANFMU in South Sudan are as follows:

a. **Survey of the River White Nile :** The White Nile River is un-surveyed, and no navigational chart is available¹⁶. Bangladesh Navy is now producing world-class charts; hence BN can help South Sudan by surveying this long river if called for. It is also mentionable that this river survey is equally important for UNMISS and the local populous.

b. **Strategic Transportation for Setting Up TOB in Remote Areas :** If BANFMU is equipped with a landing craft, it will be helpful for other Troops Contributing Countries (TCCs) to build up TOB in remote locations. It is felt strongly in Upper Nile and Jonglei State under Sector North, where road connectivity is poor, and TOB in Shilluk-dominated areas is required to be established to protect the threatened tribe.

c. **Dominance Patrol Along the Entire AOR :** Due to the high speed and other modern facilities, these LPCs can be used for dominance patrol to establish UNMISS mandates on the White Nile River. Currently, due to the limited fuel capacity and absence of a dedicated mother vessel, these LPCs can operate only within the 100 km range. The introduction of BN LCT as a mother vessel could enhance the reach of BANFMU operation in the entire AOR for prolonged operations.

d. **Training Assistance to Government Forces :** The country has a long river route. However, it doesn't have a capable riverine force that can effectively control the riverine activities. Training in hydrographic Survey, Search and Rescue, boat operation, and diving operation will help them to gain capabilities in this aspect.

Conclusion

South Sudan became a sovereign nation in July 2011¹³. Despite having natural resources, the country is still not in right path to progress. Following the independence,

the UN Security Council noticed that the prevailing security situation in the youngest country was a threat to international peace and security and decided to establish UNMISS to support the newly borne country¹³. From the beginning, the UNMISS has been working hard to implement its mandate to stabilize the country and encourage conflicting parties to enter a meaningful peace process. The Operating environment in South Sudan is challenging for peacekeepers to maintain operational awareness and a protective presence in vast areas, which are often difficult to access, to implement the mission's mandate. These challenges also include obstructions created by various actors across the country. As one of the enablers and lone marine unit of UNMISS, BANFMU is committed to doing her best in performing her assigned duties in implementing the mission's mandated tasks.

The main effort of the unit is to provide physical protection to the OpLL convoy. Besides, the unit also performs other tasks like patrol and recce following CONOPS, Mission CONPLAN, and ROE. BANFMU faces numerous challenges like security threats, machinery breakdown, and navigational hazards in performing her assigned tasks. However, BANFMU could negotiate all those challenges with courage and professional competence. The present capability of BANFMU is not adequate to cover the entire AOR. Thus, the enhancement of BNFMU's capabilities is needed to support the mission's revised mandate for lasting peace. The enhanced capability will also facilitate UNMISS's reach to remote areas to contribute more effectively to the country's upcoming election scheduled to be held by December 2024⁷. Despite all challenges, BANFMU has earned a high reputation and is considered one of the esteemed units of UNMISS due to its sound professionalism and unwavering support to establish the UNMISS mandate. The contribution and commitment of Bangladeshi peacekeepers to the UN mission is widely recognized and appreciated. BANFMU is doing her best to uphold this hard-earned recognition and is determined to work harder to create a peaceful and secure world and prosperous South Sudan.

Recommendations

The following recommendations are made:

- a. Bangladesh may offer hydrography survey assistance to the South Sudan government, which would be a great help and highly beneficial for the mass community of South Sudan.
- b. Bangladesh may offer gratis course assistance to the South Sudan People's Defense Force on a need basis.
- c. Efforts may be taken to include LCTs as support vessels with required personnel and necessary self-sustenance equipment to extend operational reach.
- d. Assistance may be provided to the local populous in agriculture sectors under Civil-military Cooperation (CIMIC) activities.

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Biography of the Writer



Captain Md Zahirul Haque, (C), BCGM, BCGMS, psc, BN was commissioned in the executive branch of Bangladesh Navy on 01 January 1996. He attended several courses at home and abroad. He is a Communication Specialist and a graduate of Defence Services Command and Staff College, Mirpur. The officer has a time mix of Command, Staff and Instructional duties. He commanded Landing Craft

Utility, Fast Attack Craft, Large Patrol Craft, Offshore Patrol Vessel and Frigate. He also commanded the lone training base of the Bangladesh Coast Guard. He was an instructor in Signal School and Doctrine Officer in the School of Maritime Warfare and Tactics. The officer also served as Staff Officer (Signals), Deputy Director (Plans) at Coastguard Headquarters, Chief Staff Officer in Bangladesh Coast Guard South Zone, Chief Staff Officer to COMCHT, Director of Signals at Naval Headquarters and Zonal Commander East Zone in the Bangladesh Coast Guard. Besides, he worked under the United Nations in South Sudan and the then Sudan. He is a keen sportsman and a passionate reader. Presently, he is serving as Director of IT and communication at Coast Guard Headquarters.

INTERAGENCIES COOPERATION VIS-A-VIS BANGLADESH'S MARITIME SECURITY OUTLOOK

Captain Mehedi Hassan, (C), NUP, psc, BN

Abstract

Bangladesh is a 'Maritime Nation' both geographically and historically. Our 'Sea Based Economy' refers to a planning framework that includes conservation, sustainable use of living/non-living resources, oil/ mineral extraction, energy generation, marine transportation etc. However, our Bay has long induced numerous non-conventional threats that are being occurred regularly/ occasionally encompassing piracy/armed robbery/petty theft, illegal/unreported/ irregular fishing, gun running, drug trafficking, human trafficking and many similar illicit activities. Apart, there are multi sectors and organizations working /involved directly at this apparatus of maritime arena directly or indirectly engaged. But despite the necessity of stake-holders' cooperation, there is no comprehensive coordination body on integrated cooperation to ensure security at sea. That is creating hindrance for the smooth flow of activities at sea due to multifarious threats. Presently this cooperation is limited to seminar, symposium, lecture and talks only. As such, for confirming smooth conduct of security-based actions, a harmonization through collaborated and central cooperation is paramount but hence we still lack. It is evident that cooperation on maritime security needs synchronization. Hereafter, inter-agencies need further review or evaluation with regard to collaborative cooperation amongst all the stake holders/professionals involved directly or indirectly in our maritime sector. Studying further, survey questionnaires and interview of concerned professionals were taken to conform and validate the proposition. Thereafter, a 'National Level Coordination Body' in the name of Bangladesh Maritime Security Coordination Body (BMSCB) has been proposed. BMSCB will thus have the highest scope of building up relationship and thereof coordinate amongst all the maritime stakeholders operating in our sea frontier so as to making sure of consistent as well as smooth operability in our Bay of Bengal.

Introduction

Bangladesh has vast sea area (1,18,813 sq km) in the Bay of Bengal (BoB) with demarcation with India and Myanmar. Our maritime arena, indeed, the sea and sea routes are the 'Life Line' of our country. This vast arena is exposed to varieties of menace along-with non-traditional threats. Sea resources/activities/operations etc are threatened by several issues encompassing piracy/armed robbery/petty theft, illegal/unreported/unregulated (IUU) fishing, limited gun running, drug trafficking, human trafficking and many similar illicit activities. But for any kind of untoward occurrence at sea, in present system there are no integrated/formulated inter-agencies coordinating body for internal as well as instant cooperation with respect to security/assistance/support at sea.

Apart from security apparatus issue, there are multi sectors and organizations working/involved directly at maritime arena/activities like, Shipping/Ocean Going Ships at both Govt owned and private sectors, Mercantile Marine Agencies, Sea Customs, Port Authorities, Energy Petroleum Mineral Resourcing Daises, Fisheries, Navy, Coast Guard etc. There are other organizations engaged indirectly to the maritime aspects like Survey Sectors, Hydrographic Centers, Educational/Training Institutions, Ship Building as well as Breaking Yards etc.

For ensuring smooth conduct of security-based actions, harmonization, 'collaborated and central' cooperation is always paramount amongst each-other. Because, without a strong and prudent cooperation to guard the maritime arena associated to reduction of marine pollution, protection of ecosystems, ocean acidification, prevention of IUU, converse of marine area, management of fisheries, aquaculture, tourism, enhancing research capacity, transfer of marine technology, implementation of UNCLOS etc. For this purpose, we need to focus holistically on the importance of the interagencies cooperation so as to ensure the security against unconventional threats for the accretion the theme of our sea based economy.

Maritime Security Outlook and Interagencies Cooperation

There have been various studies on diversified aspects of Bangladesh's Sea Based Economy. However, the activities of the state-owned maritime agencies

indicate that directly or indirectly the concept and practice of cooperation on maritime security exists. But it is inadequate and not done in a synchronized manner. For example, a merchant ship coming from abroad if attacked by the pirates/dacoits at sea. Then it gets into concerned of the Shipping Agent, Importer (sometimes Exporter), Shipping Corporation, concerned Port Authority, Mercantile Marine Department, sometimes Sea Customs, Navy, Coast Guard and few others. In order to obtain assistance by the ship, formally the ship needs to communicate to the security force maintaining chain like it's Agent – Importer/concerned Agency - Shipping Ministry/DG Shipping – AFD/Navy Headquarters – Coast Guard HQ/Fleet/Zonal Commander and finally Navy/Coast Guard Ship at sea. Another imperative challenge is communication to and from the sea. Local cargo vessels operating at our coast generally do not use satellite phone, thus cannot communicate to shore/land as they use VHF communication sets but at limited range. Since sea is very vast and not alike the land where there are manned posts at close rang, it is difficult to inform the concerned organization for assistance/support. This is because, despite there is practice to seek support but that is not organized well as no integrated body/system is existing where all the required organizations are connected to cooperate each other instantly.

As such, in order to achieve optimum output of maritime security, it is needed to review or evaluate present practice of limited system with regard to collaborative cooperation amongst all the stake-holders/inter-agencies/professionals operating at sea. The here-forth discussed integration issue for cooperation/coordination within shortest time is similarly applicable to ensure security in different facets namely sea pollution, petty theft, smuggling, incident/accident, gun running, human trafficking, illegal fishing etc.

The trait of cooperation related to Maritime Security of Bangladesh feasting Sea Based Economy and thereof identify options required for enhancing collaborative efforts, there are two basic issues are portrayed herewith for clear understanding of the present practice and future requisites namely 'current practices and grey areas of inter-organizational cooperation amongst the stakeholders' and find out the 'probable measures for enhancement and integration'.

Maritime Security and Bangladesh

Maritime Security is an old buzz words alike the Ocean itself. Maritime Security allows a nation to pursue sustainable economic growth through seaborne trade and development activities. It's a general term for the protection of vessels, structures and assets at sea both internally and externally. The areas are where ships and maritime operations need protection from terrorism, gun running, piracy, robbery, illegal trafficking of goods and people, illegal fishing, pollution etc. Maritime security infers those measures hired by owners, operators and administrators of vessels, port facilities, offshore installations and other marine organizations. The marine sector is so vast that the massive amount of goods entering into our country is a great challenge to be screened. As such, every possible precaution in minimizing the malicious exploitation is critical. Besides, since 9/11, there has been an increased global focus on protection from terrorism and other similar attacks that includes sea, too.

Geoffrey Till, a global Maritime Strategist emphasized the need for a clear and common understanding of future maritime security and to achieve further emphasized on cooperation. He identified four basic attributes that governs the use of the ocean as a source of wealth, as a life support system, a medium for trade and communications and a tradition including cooperation.

Hence mentionable, Bangladesh Navy (BN) has the solemn responsibility to ensure the safety and security for all maritime stake-holders within Bangladesh water. Therefore, BN has been providing the security of men, materials and vessels. Hence, it is essential to coherent the cooperation of all government/non-government maritime stakeholders operating at sea on different capacities.

General Nature of Threats at Maritime Sector

The general natures of unconventional and traditional threats of maritime area are as follows :

- a. Piracy, Armed Robbery and petty theft.
- b. Human Trafficking/Illegal Immigration.
- c. Drug Trafficking.
- d. Gunrunning.
- e. Act to Depict Terrorism, Insurgency and Dacoit Activities.
- f. Illegal, Unreported and Unregulated (IUU) Fishing.
- g. Maritime Accidents.
- h. Natural Catastrophe.
- j. Dreadful Impact caused due to Climate Change.
- k. Environmental Threat.
- l. Marine Pollution.

Maritime security concerns to the good order at sea. It is the component of national security that has inter-linkage between maritime threats systematically and intersects to our Sea Based Economy as well as national security. Therefore, combined and well-coordinated efforts amongst all the stakeholders operating at sea are essential so as to have positive impact.

Maintenance of law and order to ensure maritime safety at sea is traditionally the responsibility of BN and Bangladesh Coast Guard (BCG). However, the responsibility of offshore platforms remains with the owner. Due to the increase of marine traffic, fishing and offshore exploitation, the existing tasks have been increased significantly. The increased volume of tasks also include fire-fighting, casualty evacuation, imparting of training, preventive measures against collision and inspection of safety measures by ships and craft. Without the interagency cooperation the aim will not be achieved.

Maritime Interagencies Cooperation for Sustaining Security

In view of the afore-mentioned and existing maritime threats, it is obligatory for functioning of all maritime agencies in a synchronized and balanced method. The concept of synchronized cooperation amongst maritime agencies is very effective for country's national interest. Maritime stakeholders' inter-cooperation demands appreciation of the goal, respective charter of duties and responsibilities and urge on mutual cooperation. Considering the goal/duties/process of cooperation, an accommodating urge, endeavour and approach to achieve maritime benefits are noteworthy.

Deduction of the Need of Cooperation

A sustainable Sea Based Economy is impossible without conforming maritime security where integrated and inter-linked cooperation is a must factor. As far as the current internal security climate is concerned, a comprehensive maritime security cooperation framework recognizing our BoB must be established.

The necessity for cooperative security at sea is the most heightened issue. Maritime operations against illicit activities for the protection of maritime security at sea is much challenging to coordinate across state level organizations. The command and control as well as coordination is paramount hereafter. Only a combined, effective and collaborated organization under whose umbrella all maritime stakeholders are to be shaded and thereby can provide all of the necessary capabilities through cooperation to defeat these various threats at maritime frontier. As such, there is a true need for internal cooperation and partnership. This most common need necessitates a national level coordinated center for the response down to sub-level/local level. This must be addressed willingly as team work through joint effort for everyone's benefit commonly to the nation.

Bangladesh Perspective - Existing / Current Maritime Stakeholders

Maritime Sector as well as Maritime Stakeholders' inter-cooperation encompasses major impact towards the interests of Bangladesh and our nation.

The maritime stake-holders of Bangladesh are comprising of mostly following organizations:

- a. Ministry of Defence.
- b. Ministry of Home.
- c. Ministry of Shipping.
- d. Ministry of Energy Petroleum and Mineral Resource.
- e. Ministry of Fisheries and livestock.
- f. Military and Constabulary duty bound Forces, like Navy and Coast Guard.
- g. Technology and Research and Hydrographic and Meteorological Services, like Space Research and Remote Sensing Organization/SPARRSO, Meteorological department, Hydrographic and Oceanographic Centre, Survey of Bangladesh etc.
- h. Bangladesh Shipping Corporation.
- j. Department of Shipping.
- k. Sea Customs.
- l. Private sector commercial operator, like Bangladesh Ocean Going Private Ship Owners Association.
- m. All Sea Ports Chattogram, Mongla and Payra.
- n. Construction, Repair and Maintenance Organizations, like, Khulna Shipyard, Narayangong dockyard, Dry Dock of Chattogram, Anando/ Western marine private shipyards etc.
- p. Maritime Institutions for Education like, Maritime University, all Private and Govt Marine Academies, Dhaka & Chattogram University (relevant subjects), Seamen's Training Centre, Marine Fisheries Academy, Maritime Institutions for Education, Training and Research, Bangladesh Institute of Marine Technology etc.

Impact on Economy of Bangladesh in Case of Failure of Security Cooperation

Establishment of security in the maritime zone is directly related with the development and growth of country's economy. Bangladesh's economy largely

depends on the export-import. The export-import mostly takes place through sea ports (90%+). Bangladesh is very famous worldwide for her garments factory. The produced items are transported through high sea. It plays and contributes a vital and major role in the national economy of Bangladesh. To ensure the smooth run of our export and import, See lines of communication that is SLOC protection is one of the prime tasks. Besides, all kinds of living/non-living resources specially fishing and oil/gas are also vital which contribute to the economy of Bangladesh. So, all the concerned maritime agencies should come to under common umbrella and thus be cooperative to ensure safe transportation, exploration and protection. If protection/security sector collapses, then all the sea activities will fall drastically that will severely hamper the overall economy.

Glitches and Plausible Measures for Enhanced & Integrated Maritime Cooperation in Bangladesh

The extent of interdependency amongst maritime stakeholders has deepened to become increasingly linked to one another. The inter-agency cooperation could help to promote a stable maritime regime in our region with the free movement of sea borne activities and exploitation/exploration of all kinds of resources.

But there are coordinating glitches within the various agencies of our country. Various maritime organizations in the country are working under their individual ministries/organizations without a proper mechanism for controlling and coordinating respective activities. Presently, it is not known to anyone when all the maritime agencies will be integrated or be coordinated to develop mutual support for each other for speeding the need of response at quickest possible time alike international practice. For instance, Naval Control of Shipping in short NCS is generally activated during short/full scale of war situation incorporating all the maritime agencies of Bangladesh under the ‘command umbrella’ of Ministry of Defence and particularly Bangladesh Navy. A similar nature of practice needs to be conducted with more comprehensively and under a common umbrella so as to bridge the gap of cooperation amongst all the agencies operating at sea front. A coordinating body thus is deemed essential to be formed to comply as well as implement with the vast responsibilities reposed on harmonization challenge amongst various agencies. This harmonizing body may be named as Bangladesh Maritime Security Coordination Body (BMSCB).

Bangladesh Maritime Security Coordination Body (BMSCB)

The BMSCB may be established with experts of both govt and non-govt interest holders like, industrialists pertinent to maritime sectors, scientists, think-tanks, scholars, military and law enforcing senior officials etc. Their main function would be to advise BMSCB on matters concerned to maritime security along-with all the potentials / resources / activities / operations that is towards the well-being for our nation. The committee may also oversee our maritime research and development and act as national maritime watchdog.

For coordinated maritime management strategy, BMSCB may be established under Ministry of Defence. The objective is to create integrated maritime governance mechanism to foster greater involvement of various stakeholders. This organization may have officers from concerned ministries, BN, BCG and other Maritime Professionals directly or indirectly affiliated to sea and sea based activities. Their activities may involve the prioritization, budgetary allocation, national / regional level cooperation so as to explore growth of ocean resources and smooth continuation of sea borne activities of all kinds. Meanwhile, all major stake-holders should have representatives to promote this body.

Accordingly, a National Level Coordination Body may be formed comprising the following members:

- Assistant Chief of Naval Staff (Operations) - Chairman.
- Director Operations of Army & Air Force.
- Joint Secretary/Similar Status, Ministry of Shipping.
- Additional Inspector General of Police.
- Member / Senior Official Customs and NBR.
- Deputy DG Coast Guard.
- Joint Secretary/Similar Status, Ministry of Home Affairs.
- Joint Secretary/Similar Status, Ministry of Power, Energy and Mineral Resources.
- Joint Secretary/Similar Status, Ministry of Livestock and Fisheries.

- Senior Official of BIWTA.
- Member Operations Chattogram Port.
- Member Operations Mongla Port.
- Member Operations Payra Port.
- Senior Official of BFDC.
- Managing Director / Senior Official BSC.
- DG Shipping / Senior Official.
- Scholars from Civil Society / Maritime Institutions and University.
- Appropriate Official from Sea Based Cell (Member Secretary).
- Director of Naval Operations (Co-Member Secretary).

Conclusion

There are multi sectors and organizations working / involved directly at our maritime arena like Shipping, Sea Customs, Port Authorities, Energy Petroleum Mineral Resource Daises, Fisheries, Navy and Coast Guard etc. Other organizations are indirectly engaged like Survey/Hydrography Centers, Educational/Training Institutions/University, Ship Making/Breaking Yards etc. Our Bay has long induced numerous non-conventional threats being occurred regularly/ occasionally. Despite some practice for stakeholders' cooperation, there is no comprehensive coordination body as well as policy on Maritime Cooperation to ensure Maritime Security. Presently, this cooperation issue is confined mostly within seminar, symposium, lecture and talks only.

As such, for confirming smooth conduct of security-based actions, a harmonization through collaborated and central cooperation is an optimum necessity and is paramount amongst each-other of the involved agencies and hence we still lack. It is evident that directly or indirectly the concept and practice of cooperation on maritime security already exists but limited. But in order to achieve optimum output, inter-agencies need further review or evaluation with regard to collaborative cooperation amongst all the stake-holders/professionals.

To study further, different ongoing activities, unconventional threats, working agencies at sea and the difficulties of current cooperation have been analysed. Therefore, a coordinating body has been deemed very essential that needs formation to implement harmonization amongst various agencies. This harmonization body has been proposed as Bangladesh Maritime Security Coordination Body. This Body thus will have the highest scope of building up relationship amongst all the maritime stakeholders operating in our maritime frontier for cooperation on specified fields.

Cooperation can be defined as the combined effort to accomplish a task with success. So, for achieving the successful maritime goal, all the maritime agencies must have coordination. All maritime agencies are to make comprehensive effort to contribute to the national aim of achieving well-being of the people through collaborative actions.

Bangladesh is rich in her maritime heritage and several maritime communities operate in different sectors. For the security at sea, Navy thus may take the leading role to ply and coordinate amongst the maritime agencies those operate/concerned directly/indirectly at sea. Integrated coordination led by BN via formulation of Bangladesh Maritime Security Coordination Body can be the solution with a view to resolving the existing challenges of cooperation amongst various maritime agencies with respect to security outlook in our maritime arena.

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Biography of the Writer



Captain Mehedi Hassan, (C), NUP, psc, BN was commissioned in Bangladesh Navy on 01 January 1997 in executive branch with 94'B batch. He has served as SO(O) and CSO to Admin Authorities, DDNT, Drafting Commander and Director of Signals at NHQ. He has commanded 6 ships of Navy including a Frigate. He has also commanded a shore Base at Khulna named BNS Titumir. The Officer has undergone various professional courses both at home and abroad namely Communication Specialization in Pakistan, FOST in UK, Post Blast Investigation and Senior Level Defence Decision Making both in USA etc. At home, he has completed Long Communication Course, Basic Intelligence Course etc. He is a graduate from DSCSC, Dhaka and attained MDS degree. The Officer has also undergone Senior Staff Course at BPATC, Savar, Dhaka and stood 2nd amongst 28 Officers of Joint Secretary and equivalent and received 'Letter of Excellence' for overall outstanding performance in multifarious activities as per the design of the course. The Officer has write-up on maritime issue published in various local renowned newspapers. Capt Mehedi has received Peacetime Madal namely Nou Utkarsho Padak (NUP) for his valorous performance as well as contribution in Navy. Presently he is serving as Zonal Commender of Coast Guard West Zone. He is married and blessed with two daughters.

EXPLORING BANGLADESH'S FISHERIES POTENTIAL FOR BLUE TRANSFORMATION : A COMPARATIVE ANALYSIS ON A GLOBAL SCALE AND OPTIONS FOR BANGLADESH NAVY

Commander Md. Nur Hasan, (E), PCGMS, psc, BN

Abstract

Fisheries resources are crucial for ensuring both food and economic security in the country. With extensive inland waters and a vast sea area, there is significant potential in the fishery sector. Marine waters are the primary source of global fish production, while inland fisheries contribute only about 10 percent of the world's total fish output. Despite having a large sea area, our marine fish production is yet to meet satisfactory levels. The Bay of Bengal, rich in coastal and marine ecosystems, hosts around 511 marine species, including shrimps, in Bangladeshi waters. However, this potential has not been rationally utilized. The Blue Transformation, a United Nations initiative, aims to leverage the oceans' potential to enhance global food security. Collaborating closely with the Bangladesh Navy to regulate and manage fishing fleets could be a viable solution to control fishing activities in our seas.

Introduction

Bangladesh is one of the leading fish producing countries of the world. Fisheries resources are playing vital role for the food security and economic security of the country. Fish are highly efficient at converting food into animal proteins, with a conversion rate of 1 kg of body weight gained for every 1.5 kg of feed consumed. This efficiency is comparable to poultry in terms of converting feed protein into body protein and generally surpasses that of livestock animals¹. Bangladesh has become a self-sufficient country in fish production providing 67.8g of fish per person in daily dietary consumption. The GDP growth in the fisheries sector is 2.43 percent and the contribution of the fisheries sector in the overall agriculture sector is 22.14 percent in FY 2022-23². With large inland water and vast sea area, the country has significant potential in fishery sector.

1. Damazy J Tilgner. Seafood:Resources, Nutritional Composition and Preservation, 1989, CRC Press, Inc. Boca Raton, Florida.

2. DoF 2023. Year book of Fisheries Statistics of Bangladesh 2022-23. Volume: 40, Published: December 2023, Published by: Director General Department of Fisheries, Bangladesh. Available at www.fisheries.gov.bd.

Marine water is the main source of fish production in the world. Inland water fishery contributes about 10 percent of the world total fish production. Bangladesh was ranked 3rd in inland open water capture production and 5th in aquaculture. In spite of having vast sea area, our marine water fish production is not at satisfactory level. Many rivers of our country have become fishless and lot of habitats depleted from the river due to water pollution, water development, industrialization, especially textile industry and many other reasons.

The Bay of Bengal is blessed with rich coastal and marine ecosystem. It has a wide range of biodiversity such as fishes, shrimps, mollusks, crabs, mammals, seaweeds, etc. Around 511 marine species, along with shrimps, exist within Bangladeshi waters. This potential was never harvested rationally. Marine fishing requires technology and knowledge on the fisheries stocks, systematic exploration, biological and ecological aspects. But our fishermen and coastal community are not aware of required knowledge. Even our fishing trawlers and boats are not equipped with modern fishing gears. So, now is the time to give maximum importance in marine fisheries sector.

Blue Transformation and Importance of Fisheries

The Blue Transformation is a United Nations initiative designed to harness the potential of the oceans to support global food security. The UN predicts that the world's population will reach 10 billion by 2050. Population growth, economic development, and urbanization have increased the demand for food and high-quality protein, leading to a shift towards more resource-intensive diets. This shift has significant health and environmental costs. Our current food systems contribute to over one-third of greenhouse gas emissions, use up to 70 percent of the planet's freshwater, and cause significant biodiversity loss. We need to change the way of producing, processing, trading, and consuming food, with sustainability as the focus of this transformation.

Foods like salmon, lobster, and shrimp are commonly referred to as "seafood." However, the term "aquatic foods" (or "blue foods") encompasses all animals, plants, and microorganisms originating from bodies of water. Aquatic foods include those grown in or harvested from water, covering all types of fish,

shellfish, mollusks, edible crustaceans, reptiles, amphibians, and mixtures of aquatic and synthetic foods, such as surimi³. Aquatic foods are very nutritious and can help improve food security. They are rich in omega-3 fatty acids and essential nutrients. They also have diverse species, can be produced more efficiently and have a smaller environmental impact compared to land animals. This makes them accessible to vulnerable communities who rely on water resources. The Blue Transformation initiative aims to expand aquatic food systems to provide healthy, affordable diets and promote environmental care and growth for communities that depend on fishing and aquaculture, ensuring everyone benefits.

Sectors of Fisheries

According to the fishing places, there are two types of fisheries :

a. **Inland Fisheries** : Inland fisheries involve activities aimed at extracting fish and other aquatic organisms from inland waters. Small-scale fisheries depend on various inland water bodies, including ponds, rivers, beels, floodplains, haors, lakes, dead rivers (baors), wetlands, and reservoirs⁴. However, it may be open water like rivers, beels, flood plains etc. or closed water like ponds, reservoirs etc. Inland fisheries are two types: Inland Fisheries (Capture) and Inland Fisheries (Culture). Examples are catla, rohu, mrigal etc.

b. **Marine Fisheries** : Marine fisheries pertain to fishing activities conducted in oceans and seas, encompassing coastal, offshore, and deep-sea areas. Examples include shrimp, tuna, and sardines. In our country, marine fishing is performed using larger boats such as trawlers in waters deeper than 40 meters. Artisanal fishing occurs in shallow waters, typically within 40 meters of depth, using either mechanized or non-mechanized boats.

3. Law Insider, Aquatic foods definition, Retrieved from <https://www.lawinsider.com/dictionary/aquatic-foods>

4. DoF 2020. Year book of Fisheries Statistics of Bangladesh 2019-20. Volume: 37, Published: March 2021, Published by: Director General Department of Fisheries, Bangladesh. Available at www.fisheries.gov.bd.

State of World Fisheries Resources

In 2022, total fisheries and aquaculture production hit a record high of 223.2 million tons, consisting of 185.4 million tons of aquatic animals and 37.8 million tons of algae. Global capture fisheries production amounted to 92.3 million tons, valued at approximately USD 159 billion. This included 91.0 million tons of aquatic animals, with 79.7 million tons caught in marine areas and 11.3 million tons in inland waters, along with 1.3 million tons of algae⁵. This data indicates that the majority of fisheries are captured from marine waters, with inland water fisheries contributing only about 10 percent of the total. A few countries dominate global marine production. Table-1 lists the top 10 major producers for marine and inland water capture. The top seven producers represent over 50 percent of total marine captures, with China alone contributing 14.9 percent of the world’s total marine capture⁶. However, top 10 marine capture production countries are from different area from the world which indicates marine fisheries are given more importance than inland water fisheries all over the world.

Table-1: Major Producing Countries of the World (2022)

Serial	Marine Capture Production (Million Tons)		Inland Water Capture Production (Million Tons)	
	Country	Production	Country	Production
1	China	11.82	India	1.89
2	Indonesia	6.84	Bangladesh	1.32
3	Peru	5.23	China	1.16
4	Russia	4.72	Myanmar	0.85
5	USA	4.24	Indonesia	0.46
6	India	3.60	Uganda	0.45
7	Vietnam	3.44	Tanzania	0.403
8	Japan	3.89	Cambodia	0.402
9	Norway	2.44	Nigeria	0.36
10	Chile	2.23	Egypt	0.34

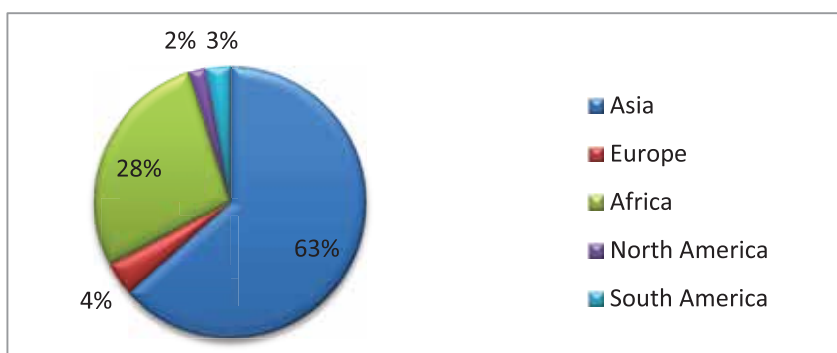
Source: Food and Agriculture Organization of the United Nations (FAO) 2024

5. FAO 2024. The State of World Fisheries and Aquaculture 2024, Towards Blue Transformation. Rome, Italy. Available at <https://doi.org/10.4060/cd0683en>.

6. Ibid.

Inland water fisheries are important for Asia and Africa comparing to the other continents of the world. 91% of inland fisheries of total production are from the countries of Asia and Africa. Inland fisheries contribution of different continents is shown in figure-1.

Figure-1: Inland fisheries contribution of different continent



Source : Food and Agriculture Organization of the United Nations (FAO) 2024

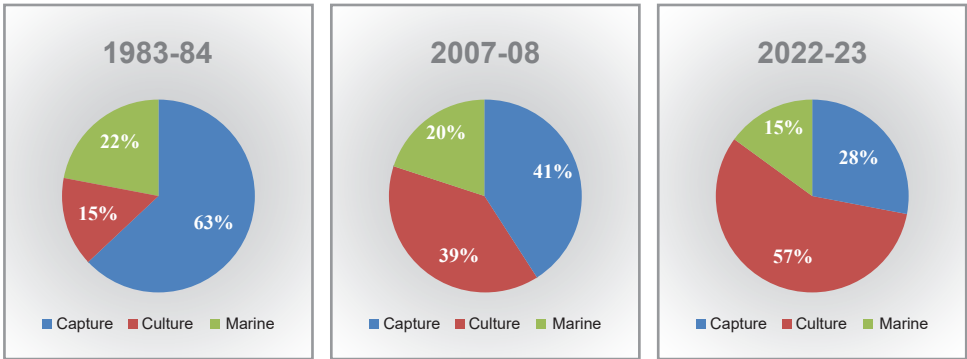
Fisheries Resources of Bangladesh

Bangladesh is fortunate to possess vast fisheries resources. In FY 2022-23, the country's total fish production reached 4.915 million MT, surpassing the target of 4.782 million MT. According to FAO report, Bangladesh ranks 3rd in inland open water capture production and 5th in aquaculture production. Over 12% of the population, including women, are directly or indirectly involved in various activities within the fisheries sector for their livelihood⁷. However, Bangladesh's fisheries resources are primarily dependent on inland fisheries, particularly inland culture production. The country has one of the largest and most active deltas, sustained by three major rivers: the Padma, the Meghna, and the Jamuna. Additionally, as a riverine nation, Bangladesh boasts around 700 rivers, including tributaries, with a combined length of approximately 24,140 km, forming the world's most intricate river system. Unfortunately, the contribution of inland open water fisheries to total fish production has been declining over time.

7. DoF 2023, op. cit.

Similarly, despite having a long coastline and vast sea area, the contribution of marine fisheries to total fish production has also decreased significantly. Figure-2 illustrates the contributions of inland capture, culture, and marine fisheries to total fish production over different years.

Figure-2: Contribution of inland capture, culture and marine fisheries to total fish production



Source : Year book of Fisheries Statistics of Bangladesh

a. **Inland open water (capture) fishery of Bangladesh :** Capture fisheries in inland open waters involve harvesting fish from naturally occurring stocks in rivers, estuaries, beels, floodplains, including haors, Kaptai Lake, and the Sundarbans, along with subsistence fishing. In FY 2022-23, the total inland open water area was 38,61,281 hectares, with a total fish production of 13,83,283 metric tons⁸. Over the past 10 years, the inland open water area has decreased by 1,64,468 hectares. Although inland open water fisheries remain a significant source of total fish production, their share has dropped from 63% in FY 1983-84 to only 28% in FY 2022-23 (Figure-2). The main reasons for this decline are overexploitation, water development, weak law enforcement, lack of awareness, and water pollution. Bangladesh, the world's second-largest garment manufacturing hub after China, often discharges wastewater directly into rivers and streams, exacerbating the issue⁹.

8. Ibid.

9. TBS Report. Fashion hunger destroying the Asian river. 29 September 2020, The Business Standard. Retrieved from <https://www.tbsnews.net/environment/fashion-hunger-destroying-asian-rivers-139054>.

b. Inland closed water (culture) fishery of Bangladesh : Closed water refers to inland water areas isolated from other waters and fisheries, including fish farming in fresh and estuarine waters. Bangladesh practices two types of aquacultures: freshwater and coastal. There is no marine aquaculture in the country, and no marine or coastal finfish are farmed¹⁰. In FY 2020-21, the total aquaculture area was 8,43,729 hectares, with a total production of 26,38,745 metric tons¹¹. Aquaculture contributes more than half of the country's fish production and is growing at a rate of approximately 4 percent.

c. Marine fisheries : The coastal and marine environment of Bangladesh benefits from a warm tropical climate and high rainfall, fostering one of the world's most productive ecosystems. Following the decision of the International Tribunal for the Law of the Sea (ITLOS), Bangladesh gained sovereign rights over more than 1,18,813 square kilometers of territorial sea, 200 nautical miles of Exclusive Economic Zone (EEZ), and all living and non-living resources under the continental shelf up to 354 nautical miles from the coastline. In Bangladeshi marine waters, fish resources are extracted at three levels: (1) up to 40 meters in depth from the coastline where regular fishing boats operate; (2) from 40 to 200 meters in depth where mid-water trawlers operate; and (3) from 200 meters in depth to the end of the EEZ where long-liner trawlers operate¹².

10. Shamsuzzaman Md. Mostafa, Islam Mohammad Mahmudul, Tania Nusrat Jahan, Al-Mamun Md. Abdullah, Barman Partho Protim, Xu Xiangmin (2017). Fisheries resources of Bangladesh: Present status and future direction. *Aquaculture and Fisheries*, Volume 2, Issue 4, July 2017. Retrieved from <https://www.sciencedirect.com/journal/aquaculture-and-fisheries/vol/2/issue/4>.

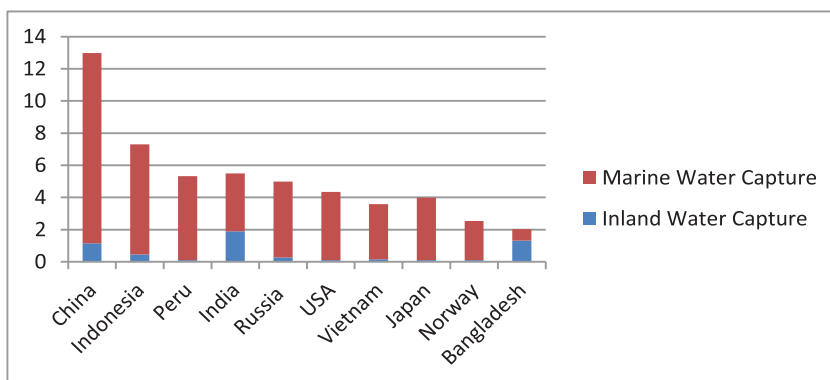
11. DoF 2021. Year book of Fisheries Statistics of Bangladesh 2020-21. Volume: 38, Published: January 2022, Published by: Director General Department of Fisheries, Bangladesh. Available at www.fisheries.gov.bd.

12. Islam, M. M., Shamsuzzaman, M. M., Mozumder, M. M. H., Xiangmin, X., Ming, Y., & Jewel, M. A. S. (2017). Exploitation and conservation of coastal and marine fisheries in Bangladesh: Do the fishery laws matter? *Marine Policy*, volume 76, pp 143-151.

Comparing Bangladesh's Capabilities with Global Perspectives

In terms of inland fisheries, Bangladesh has a significant advantage compared to other countries in the world. The country has a large network of rivers and canals, which provides a suitable habitat for fish species. Moreover, the adoption of modern aquaculture practices has helped to increase the production of inland fish. Bangladesh's production of inland fish is ranked second in the world. Even though, we have lot of scope to improve inland fisheries, especially inland open water fisheries. On the other hand, if we look towards the marine fisheries, production of marine fish is much lower compared to other countries in the region, such as India, Indonesia, and Thailand. Figure-3 shows the top ten global capture producers of the world for the year 2022. It is evident from figure-3 that, the contribution of marine fisheries to total production is very important. Marine captures have lion's shares for all the countries of top ten global capture producers other than Bangladesh.

Figure-3 : Top ten global capture producers, 2022



Source : Food and Agriculture Organization of the United Nations (FAO) 2024

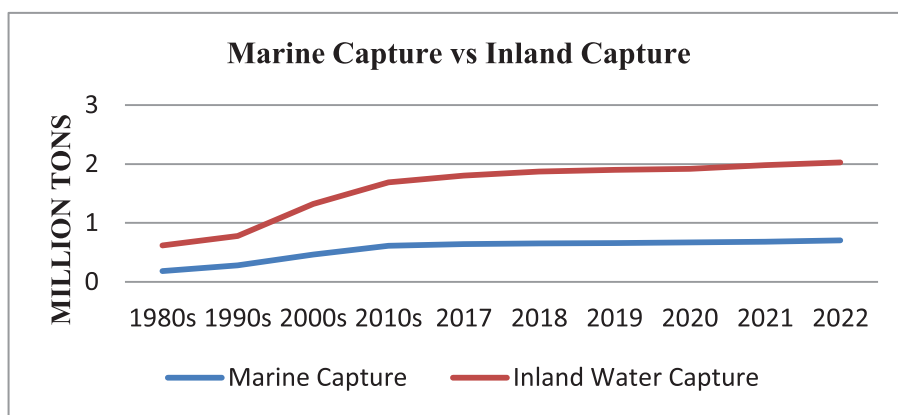
According to the FAO, the world had an estimated 4.1 million fishing vessels in 2020. Asia hosts the largest fishing fleet, with around 2.68 million vessels, making up about two-thirds of the global total. China alone has the largest fishing fleet, with an estimated 5,64,000 vessels. Globally, around 2.5 million vessels are

equipped with engines, comprising 62 percent of the total fishing fleet. Although the number of fishing vessels worldwide is decreasing, there is a trend towards larger, more powerful vessels with more efficient fishing gear, enhancing the efficiency of marine fishing. In Bangladesh, the fishing fleet consists of 234 trawlers, 32,859 mechanized boats, and 34,810 non-mechanized boats¹³.

Marine capture fisheries in Bangladesh are categorized into artisanal and industrial fisheries. Industrial fishing is carried out by trawlers, while artisanal fishing uses mechanized and non-mechanized boats. Artisanal fisheries account for about 95% of the total marine production and involve various traditional fishing gears and crafts. Only a few of these gears are used with mechanized boats, while most are operated with country boats, and some even without boats¹⁴.

Figure-4 provides a comparative view of marine capture and inland capture fisheries in Bangladesh. Over the past forty years, the total production from both marine and inland captures has increased, but the growth rate of marine fisheries production has been significantly lower compared to inland water fisheries. Therefore, there is substantial potential for improvement in the marine fisheries sector in Bangladesh.

Figure-5 : Marine capture and inland capture of Bangladesh



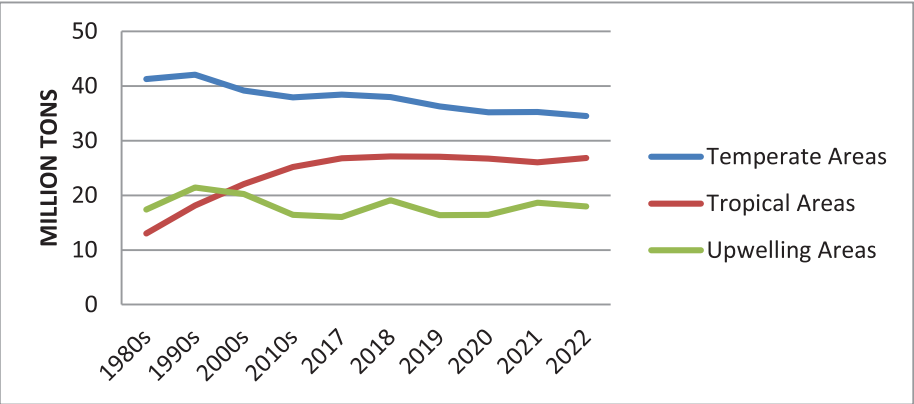
Source : Food and Agriculture Organization of the United Nations (FAO) 2024

13. DoF 2021, op. cit.

14. Hasan Jahid. Seminar paper on Fisheries Resources of Bangladesh and its Future Potentials. Summer 2020, Dept. of Fisheries Management, Bangabandhu Sheikh Mujibur Rahman Agricultural University.

Bangladesh's coastal and marine environment, with its warm tropical climate, high rainfall, and nutrient-rich waters, forms one of the world's most productive ecosystems. There is significant potential for the exploration, exploitation, and management of the Bay of Bengal's living and non-living resources. Despite this potential, Bangladesh has not fully capitalized on its marine resources for economic gain. Figure-6 illustrates marine capture production trends in three main fishing areas, showing a significant increase in the production rate in tropical regions over the past forty years. Although the Bay of Bengal is a tropical area, Bangladesh has not achieved a satisfactory increase in its marine fish production rate.

Figure-6 : Marine capture production trends in three main categories of fishing areas



Source : Food and Agriculture Organization of the United Nations (FAO) 2024

Challenges and Strategies to overcome

Both inland and marine fisheries in Bangladesh face numerous challenges. Inland open water habitats have been depleted due to pollution, water development, overexploitation, and inadequate law enforcement. To boost inland fishery production, we must control pollution, particularly industrial pollution, prevent the disruption of water flows caused by various water development projects, and establish and maintain fish and wetland sanctuaries in eco-sensitive areas such as the Sundarbans, Kaptai Lake, rivers, floodplains, and coastal and marine waters.

Conservation strategies could include seasonal bans, gear restrictions, and species restrictions¹⁵.

Our marine fisheries resources are limited by several factors: (a) insufficient knowledge about the current stock by species, breeding ground locations, grow-out areas, and potential maximum sustainable yields by species, season, and location; (b) over-fishing; and (c) encroachment by trawlers from neighboring countries¹⁶. Additionally, coastal communities lack access to modern technology and knowledge. The technological development of fishing vessels has advanced significantly over the past few decades. Innovations in electronics, automation, and other technologies have greatly enhanced the efficiency and safety of fishing operations. A major advancement is the use of sonar and other sensors to locate fish stocks, enabling fishermen to target specific areas and reduce the time spent searching for fish. Another important development is the use of automated systems for tasks such as sorting and packing fish, which can greatly increase the speed and efficiency of processing. Automated systems can also reduce the risk of injury to workers, as well as reduce the amount of waste and improve the quality of the catch. The use of satellite technology has also become increasingly common, allowing fishermen to track weather patterns and ocean conditions in real-time. This can help them avoid dangerous conditions and improve their chances of finding fish. In addition, many modern fishing vessels are equipped with advanced navigation systems, including GPS and radar, which can help fishermen navigate safely and efficiently. These systems can also be used to monitor the movement of other vessels in the area, reducing the risk of collisions and other accidents. Therefore, knowledge and technological advancement in fishing sector is very important.

Options for Bangladesh Navy

Bangladesh Navy has extensive access to the entire sea area compared to other stakeholders involved in fisheries. Collaborating closely with the Navy, the use

15. Shamsuzzaman, op. cit.

16. Ibid.

of fishing fleets can be an effective solution to regulate and control fishing activities in the seas. This approach offers several advantages, including improved regulation and control of fishing activities. Navy can establish fishing quotas, regulate fishing seasons, and monitor the movements and catches of fishing vessels. This will help prevent overfishing and ensure sustainable fishing practices. Additionally, Navy can enforce fishing laws and regulations, such as size limits, mesh size, and catch limits, to ensure fishermen comply with the rules and protect marine biodiversity. Furthermore, Navy can offer protection against piracy, theft, and other criminal activities that fishermen may encounter at sea.

Navy can be instrumental in regulating and controlling fishing activities, ensuring sustainable fishing practices, and protecting marine biodiversity. However, it is crucial that Navy has the necessary expertise and resources to manage the fleet effectively. Working closely with local fishing communities and other stakeholders is essential to promote sustainable fishing practices and support economic development. This collaboration can ensure the long-term viability of the fishing industry and the welfare of coastal communities. For instance, the Tourism Authority of Thailand (TAT) has signed a Memorandum of Understanding (MoU) with the Royal Thai Navy to promote marine safety measures for the conservation of marine natural resources in support of tourism sustainability. Under the MoU, TAT and the Royal Thai Navy agree to cooperate on promoting and building confidence in marine safety measures for tourists, enhancing tourist attractions in areas supervised by the Royal Thai Navy and fostering sustainable conservation of marine natural resources through tourism¹⁷. Similarly, Bangladesh Navy can establish agreements with stakeholders to effectively manage and regulate marine fishing.

17. TAT News. TAT and Royal Thai Navy co-promote marine safety and sustainable tourism. Bangkok, 29 September, 2021. Retrieved from <https://www.tatnews.org/2021/09/tat-and-royal-thai-navy-co-promote-marine-safety-and-sustainable-tourism/>.

Conclusion

Bangladesh is one of the leading fish producing countries only because of inland water fisheries, particularly inland culture fisheries production. Only about 10 percent fishes of world total fish production are inland water fisheries. For Bangladesh, scenario is completely different. Only 15 percent fishes of total fish production of Bangladesh are marine fisheries, rest inland water capture and inland water culture fisheries. Inland open water captures are at high risk due to pollution, industrialization, water development and lack of rules implementation. Few rivers have hardly any fish species due to pollution and overexploitation. Therefore, marine water fisheries can be a good option to increase total fish production.

Bangladesh has got long coastal area and vast sea area. With a considerable fishing fleet and lot of people engaged in marine fishing, we failed to optimize our marine water fish production due to lack of knowledge, technology and fishing management. We have huge limitation on deep sea fishing and distance fishing. It is possible to get 80,00,000 MT fish form Bay of Bengal every year but we are getting only 7,00,000 MT¹⁸. To realize the potential, the government departments, non-government organizations, researchers and development partners can play important role in the formulation of management plans. Bangladesh Navy can co-operate in this sector to regulate associated rules and laws. Proper exploration of marine fisheries can boost up total fish production of Bangladesh.

18. Shamim Ahmed. Ocean Economy Only on Paper. Daily Bangladesh Protidin, 08 May 2023.

Biography of the Writer



Commander Md. Nur Hasan, (E), PCGMS, psc, BN was commissioned in Bangladesh Navy on 21 December 2001 in the Engineering branch. He has completed BSc in Mechanical engineering from Chittagong University of Engineering and Technology (CUET). He did Missile Airframe and Engine Engineer Course from Naval Aeronautical Engineering Academy, China. He also did Post Graduate Diploma in Project Planning, Development & Management Course from National Academy for Planning and Development (NAPD). He obtained MSc in Defence Studies from Bangladesh University of Professionals (BUP). He served in RAB, Coast Guard Headquarters, Navy Headquarters, different ships and BN Dockyard. He was awarded with President Coast Guard Medal Seba (PCGMS). He participated in United Nations Mission in DR Congo (MONUSCO). Presently he is serving as Deputy Director Naval Engineering at Naval Headquarters.

DIGITAL BATTLEGROUND : CHARTING CYBER THREATS IN NAVAL WARFARE

“We worried for decades about WMDs – Weapons of Mass Destruction. Now it is time to worry about a new kind of WMDs – Weapons of Mass Disruption.”

-John Mariotti, Author of The Chinese Conspiracy¹

Commander Mahbuba Afroze, (L), afwc, psc, BN

Abstract

Traditionally, naval warfare has been centered on physical battles involving ships and submarines. However, the advent of the digital age has introduced new vulnerabilities and attack vectors, making it essential to comprehensively understand cyber threats and their implications for naval strategy and defence. This paper delves into the evolution of cyber threats within naval contexts, highlighting key types such as malware, phishing, ransomware and Distributed Denial-of-Service (DDoS) attacks. By examining notable incidents including breaches of naval communication systems and attacks on critical infrastructure, the paper demonstrates the tangible impacts these cyber threats can have on naval operations. These examples emphasize the critical need for robust cybersecurity measures to safeguard sensitive data, communication networks and operational capabilities. The paper underscores the importance of continuous training and awareness programs for naval personnel to foster a culture of cyber security. Looking forward, the paper explores future trends in naval cyber warfare, such as the integration of artificial intelligence and machine learning for enhanced threat detection and response, the potential impact of quantum computing and the role of autonomous systems in cyber defence. By mapping the landscape of cyber threats and evolving strategies to counter them, this paper aims to provide a comprehensive understanding of the digital battlefield in the context of modern naval warfare.

Introduction

Technological advancements have enhanced the effectiveness and power of weapons and systems used in naval warfare, but they have also introduced security concern.

1. www.thechinesecomspiracy.com accessed on 23 May 2024.

Naval warships depend on multiple computer networks to operate at sea and carry out their missions, and a fundamental principle is that a computer becomes vulnerable once connected to a network. As technology progresses and systems are increasingly managed in a network-centric manner, thus securing these systems becomes crucial. While advancements in command control systems, network-centric ship management and satellite capabilities have brought significant benefits to warfare, they have also made ships more susceptible to cyber-attacks than ever before.

Navy, being sensitive organ of the Armed Forces, always remains as lucrative targets for vested cyber-attackers; be it state actor or lone hacker (D. Alford, 2000). No Navy is exception to it. In this paper the basic elements that constitute cyber environment of Navy is highlighted. Subsequently, existing cyber warfare status of navies is also examined to find out the potential threats, risk and vulnerabilities for proposing a framework to enhance cyber security capability.

Taxonomy of Cyber Warfare Term

Cyber warfare employs digital attacks to target a nation, causing damage comparable to that of traditional warfare and disrupting essential computer systems and networks². The related aspects of cyber warfare are discussed below:

- a. **Cyber Security Computer Security.** Also known as cyber security or information technology security, involves safeguarding computer systems and networks from attacks by malicious actors that could lead to unauthorized information disclosure, theft or damage to hardware, software, or data.
- b. **Cyber Threats.** A cyber threat, or cyber security threat, represents the risk of a cyber-attack. Essentially, it is defined as a malicious act aimed at stealing or damaging data or disrupting the digital stability and wellbeing of an organization.
- c. **Cyber Risks.** Cyber risks refer to the potential threats and vulnerabilities that can lead to the unauthorized access, disruption, damage or theft of

2. <https://www.imperva.com/learn/application-security/cyber-warfare> accessed on 23 May 2024.

remains undetected for a prolonged period (Priya & Sriram, 2022). Recently, the term has also been used to describe non-state-sponsored groups executing large-scale targeted intrusions for specific objectives. These attacks require substantial investment. In contrast, lower-tier attacks generally cause less harm to potential victims. Therefore, it is essential to integrate counter-cyber systems into warships to defend against cyber threats. Broadly, there are two categories of cyber-attacks that may impact navy ships:

a. **Untargeted Attacks.** This is the most prevalent and widespread type of intentional threat. These attacks are driven by the intent to damage people's software, but they do not target any specific individual or group.

(1) **Malware** : Malware³ and viruses are among the most common cyber threats capable of disrupting naval operations by targeting critical systems. These malicious software programs can infiltrate navigation, weapon systems and communication networks leading to potential operational failures.

(2) **Phishing** : Phishing attacks⁴ in naval operations can compromise security by tricking personnel into revealing sensitive information or downloading malware. These attacks can lead to unauthorized access to critical systems disrupting navigation, communication and weapon systems.

(3) **Spyware** : Spyware in naval operations can surreptitiously collect and transmit sensitive information to adversaries compromising operational security. This stolen data can include intelligence on naval strategies, ship movements, and communication protocols, giving enemies a tactical advantage.

(4) **Worm** : Worms in naval operations can rapidly spread across networks, infecting multiple systems and causing widespread disruption. These self-replicating programs can disable critical systems, such as

3. Malware is a collective term used to describe any software intentionally designed to cause damage to a computer, server, client, or computer network.

4. Phishing is a type of cyber-attack that involves sending fraudulent communications that appear to come from a reputable source.

navigation, communication and weapons control, compromising mission readiness and execution.

(5) **Scanning** : Scanning in naval operations involves opponents probing networks and systems for vulnerabilities which can compromise security. By identifying weak points, attackers can plan and execute more targeted and effective cyber-attacks, such as exploiting unpatched systems or weak passwords. This reconnaissance can lead to unauthorized access, disrupting critical systems and control.

(6) **Water Holing** : Water holing attacks⁵ in naval operations involve compromising websites or resources commonly accessed by naval personnel. This can compromise sensitive information, disrupt communication channels, or compromise the integrity of critical systems onboard ships.

Figure 2 : Targeted and Untargeted Attacks



(Author's construction based on the study)

b. **Targeted Attacks.** It is a cyber-attack specifically aimed at a ship's systems and data. Targeted attacks tend to be more sophisticated, utilizing tools and techniques specifically designed for attacking a ship.

(1) **Denial of Service (DoS)** : DoS attacks aim to overwhelm and disable networks by flooding them with excessive traffic. These attacks can disrupt

5. This is a social engineering attack that takes advantage of the amount of trust that users give to websites they regularly visit.

naval communication networks rendering them unavailable during critical operations.

(2) **Social Engineering** : This refers to manipulation techniques that exploit human behaviour and errors to gain access to sensitive or confidential information, systems, or valuables. These malicious software programs can infiltrate navigation, weapon systems, and communication networks, potentially leading to operational failures.

(3) **Subversion** : Subversion can severely compromise the integrity and effectiveness of naval warfare. By tampering with navigation and weapon systems, adversaries can cause navigational errors or render weapons ineffective.

(4) **Zero Day Attack** : A Zero Day Attack⁶ in naval operations can have devastating consequences due to the exploitation of unknown vulnerabilities. Such attacks can disable critical systems, including navigation, weaponry and communication, leading to operational paralysis.

(5) **Spear-Phishing** : Spear-phishing in naval operations can have severe impacts due to its highly targeted nature. Attackers create convincing messages to deceive particular individuals into disclosing sensitive information or downloading malware.

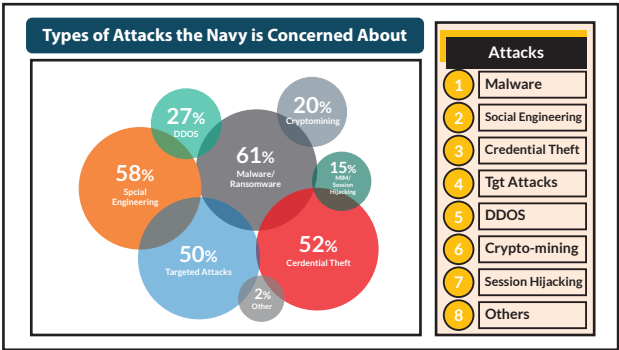
(6) **Brute Force** : Brute force attacks⁷ in naval operations can severely compromise system security by systematically cracking passwords to gain unauthorized access. Once inside, attackers can disrupt command and control systems, leading to communication breakdowns and operational delays.

Navies are vulnerable to both Targeted and Untargeted Attack (McGee, Vanesa, 2023). However, Navies are concerned about the following types of attacks as those are common.

6. An attack that exploits a software vulnerability before the software developer has a chance to fix it is called a zero-day attack.

7. A brute force attack is a hacking method that uses trial and error to crack passwords, login credentials, encryption keys, or URLs.

Figure 3 : Types of Attack Navies are Concerned About



(Author’s Construction based on study)

Cyber Threats and Vulnerabilities in Naval Warfare

Naval ships are increasingly adopting digitized, integrated and automated systems. Nearly all critical systems across naval ships, aircraft, submarines and command centres are interconnected and often linked to the internet. Dependence on the Global Positioning System (GPS) for navigation and precision weapons presents a significant cyber vulnerability, with risks of unauthorized access or malicious attacks on naval ships' systems and networks (Howard &DaCruz,2023).

Figure 4 : Cyber Security Threat onboard a Ship



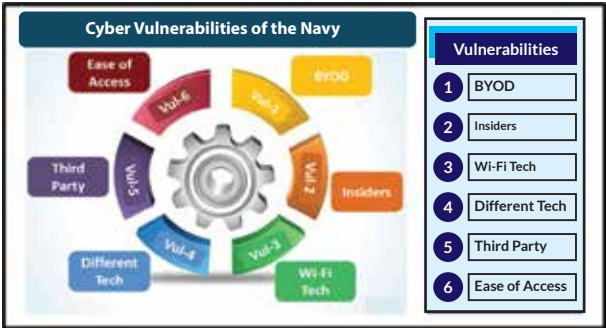
(Author’s Construction based on Maritime Cyber Security⁸)

8. <https://www.dnv.com/maritime/insights/topics/maritime-cyber-security> accessed on 23 May 2024.

There are technological, procedural and manual interventions which also pose threats to and create vulnerabilities in all three types of assets of Navies. Navy uses various utility software for administrative purpose. Navy uses Data Centre where software and applications are hosted. This Data Centre is maintained by service experts as well as civil experts from outside. Taking this scenario into consideration, followings are the vulnerabilities of Navies in respect to Cyber Security :

- a. **Bring Your Own Device (BYOD) Program.** BYOD program allows one to remain logged in into more than one device simultaneously. Careless handling of those devices may result into unauthorized access to the systems and networks.
- b. **Insiders.** Insiders have better knowledge on the assets than any one remaining outside. Therefore, malicious insiders may leak valuable information to reach the system.
- c. **Wi-fi Technology.** Business and Administration Network is vulnerable due to Wi-fi technology as ID and password for the common spaces is same for all.
- d. **Different Technologies.** As the service seekers demand various services and use different types of technology to reach server, it remains as a challenge for naval ships to deal with.
- e. **Third Party.** The service management companies as third party remain as vulnerable to navies as it has legitimate access to network and some of the facilities.
- f. **Ease of Access.** Too much ease of access to the assets is also another vulnerability. Providing passwords to many people to deal with any situation quickly poses threat to navies.

Figure 5 : Cyber Security Vulnerabilities



(Author’s Construction based on study)

Real-world Examples of Cyber Attack and Its Impact

These examples highlight the diverse methods and impacts of cyber-attacks, ranging from targeted operations against critical infrastructure to widespread ransom ware campaigns and supply chain compromises. Each instance highlights the critical importance of strong cyber security measures and proactive defence strategies in addressing and reducing cyber threats.

a. **Stuxnet.** Stuxnet was a sophisticated cyber weapon discovered in 2010⁹. It aimed on Iran's nuclear facilities, particularly its centrifuges employed for uranium enrichment. Stuxnet caused physical damage by altering the speed of centrifuges, leading to operational disruptions and delaying Iran's nuclear program (Josh, 2022).

Figure 6 : Stuxnet Attack on Iran’s Nuclear Facilities



Source: BBC News Portal¹⁰

9. Stuxnet is a powerful computer worm designed by U.S. and Israeli intelligence that to disable a key part of the Iranian nuclear program.

10. <https://www.linkedin.com/pulse/russia-vs-estonia-first-cyber-war-2007> accessed on 28 May 2024.

b. **The NotPetya Attack.** The NotPetya cyber-attack in 2017 serves as a clear demonstration of the potential impact of cyber threats on critical infrastructure. Although initially targeting Ukrainian organizations, the malware quickly spread globally, affecting various industries, including maritime operations. A.P. Moller-Maersk, a major shipping company, suffered significant disruptions, highlighting the vulnerability of maritime operations to cyber-attacks (McQuade, 2018). This incident highlights the crucial need for strong cyber security measures in naval operations to prevent similar disruptions.

c. **The Sea Dragon Incident.** The Sea Dragon incident in 2018 involved the unauthorized acquisition of sensitive data from a U.S. Navy contractor's computer network. The stolen data included information on undersea warfare, demonstrating how cyber espionage can compromise naval capabilities. This incident underscores the importance of rigorous cyber security measures, such as secure networks and robust access controls, to safeguard sensitive information and prevent espionage.

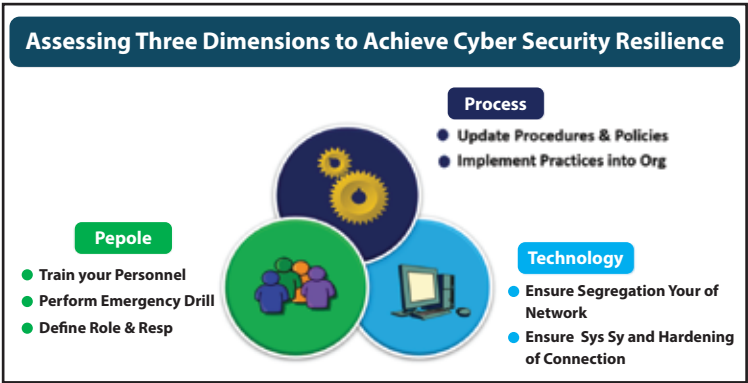
d. **The Iranian Cyber Attacks on U.S. Naval Systems.** In 2019, Iranian cyber attackers targeted U.S. naval systems, attempting to infiltrate and disrupt operations. These attacks highlight the growing threat posed by nation-state actors and the need for advanced threat detection and response capabilities. By enhancing cyber security measures, the Navy can better defend against sophisticated adversaries and protect critical systems from compromise.

Concept of Cyber Security Enhancement in Navies

Assessing Cyber Security Resilience Onboard Ships. Achieving cyber security resilience onboard navy ships requires a multifaceted approach. It begins with implementing robust cyber security protocols that encompass continuous monitoring of onboard systems for potential threats and vulnerabilities. Network segmentation and strict access controls are essential to protect critical operational systems from unauthorized access or manipulation. Regular training for personnel

on cyber hygiene practices and immediate response protocols are crucial to mitigate risks effectively (Kanwal, Shi, Kontovas, & Chang, 2022). However, Cyber Experts recommend assessing three dimensions relevant to achieve Cyber Security Resilience¹¹ onboard ships.

Figure 7 : Assessing Cyber Security Resilience Onboard Naval Ships



(Author’s Construction based on study)

Cyber Security Enhancement Elements : A clear concept is paramount to enhance cyber security in navies. Such concept may encompass risk assessment, protection measures and developing a framework.

Figure 8 : Cyber Security Enhancement Concept

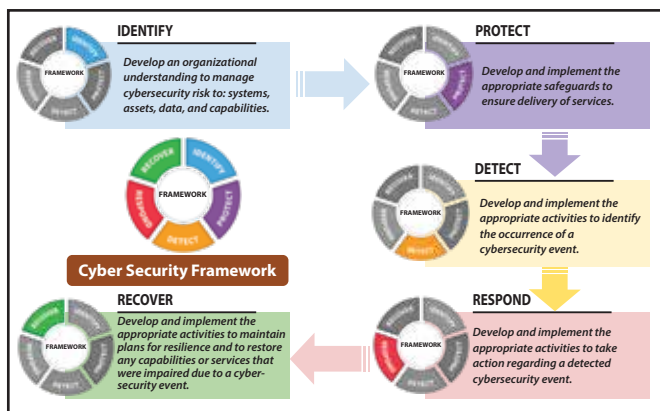


(Author’s Construction based on study)

11. Cyber resilience is the ability of an organization to prepare, respond and recover from cyber attacks.

Cyber Security Enhancement Framework¹². An implementable Framework will enhance cyber security of Navies. Each element of framework is required to be implemented in the field of Navies' Cyber activities.

Figure 9: Cyber Security Framework for Navies



(Author's Construction based on study)

Future Trends and Emerging Technologies

Future trends and emerging technologies in cyber warfare are expected to include advancements in artificial intelligence (AI) for both offensive and defensive purposes, such as AI-powered malware and autonomous cyber defence systems.

a. **Quantum Computing and Cryptography.** Although quantum computers have the capability to compromise current encryption methods, they also present opportunities to create more secure cryptographic techniques. The navy should remain vigilant regarding developments in quantum computing and allocate resources to research the development of encryption methods that can resist quantum threats, thereby ensuring the enduring security of communication and data systems.

b. **Artificial Intelligence and Machine Learning.** AI and machine learning technologies can significantly enhance threat detection and response

12. Cyber security Framework is a set of guidelines for mitigating organizational cyber security risks.

capabilities. By integrating AI and machine learning into their cyber security infrastructure, the navy can improve their ability to detect and respond to emerging threats in real-time.

c. **Internet of Things (IoT) Security.** The growing integration of IoT devices in naval operations poses new security challenges. IoT devices, such as sensors and communication equipment, can be vulnerable to cyber-attacks if not properly secured.

Options for Navy to Enhance Cyber Security

Cyber security countermeasures for navies involve several critical strategies to protect against cyber threats. In a nutshell, a suggested cyber security countermeasures are as follows:

a. **Comprehensive Cyber Hygiene Training.** A key strategy to bolster cyber security is thorough cyber hygiene training for all naval personnel. By educating personnel about cyber threats and best practices, the navy can mitigate the risk of successful social engineering attacks and enhance overall security awareness.

b. **Enhanced Network Segmentation.** Network segmentation entails partitioning a network into smaller and isolated segments to contain the spread of malware and control access to essential systems. For example, separating operational systems from administrative networks can prevent malware from spreading from less secure areas to critical operational systems.

c. **Advanced Threat Detection and Response.** Implementing advanced threat detection systems, powered by artificial intelligence (AI) and machine learning, can greatly improve the navy's capacity to detect and respond to cyber threats effectively. These systems analyze network activity, detect irregularities and promptly recognize potential threats. By harnessing AI and machine learning, the navy can proactively address emerging cyber threats and strengthen its defensive capabilities.

d. **Regular Security Audits and Penetration Testing.** Regular security audits and penetration tests are crucial for identifying vulnerabilities before they can be exploited by adversaries. Security audits involve thorough evaluations of the navy's IT infrastructure to pinpoint weaknesses and propose enhancements.

e. **Zero-Trust Architecture.** Implementing a zero-trust security model can substantially mitigate the risk of unauthorized access. In this architecture, every access attempt is rigorously verified, irrespective of the requester's network location. This strategy includes stringent access controls, ongoing monitoring and multi-factor authentication.

f. **Supply Chain Security.** Securing the supply chain is crucial to preventing compromised components from entering naval systems. The navy should implement stringent security checks and balances throughout the supply chain, including vetting suppliers, conducting thorough inspections, and utilizing secure procurement processes.

g. **Collaboration with Cyber Security Experts.** Collaborating with leading cyber security firms, academic institutions, and governmental agencies can provide the navy with access to cutting-edge expertise and technologies. Collaborating with external experts allows the navy to stay updated on current cyber threats and best practices, thereby strengthening their defensive capabilities.

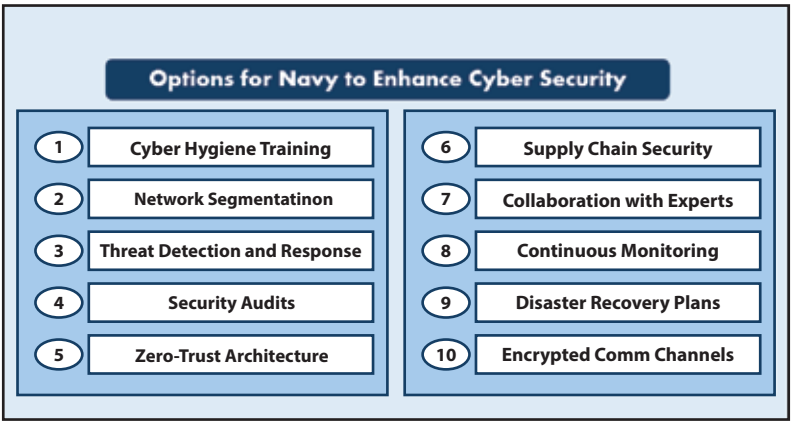
h. **Continuous Monitoring and Real-time Analytics.** Establishing a 24/7 Security Operations Center (SOC) with real-time monitoring capabilities is essential for maintaining constant vigilance over naval networks. Continuous monitoring allows for the rapid detection and response to emerging threats minimizing potential damage. Real-time analytics can identify patterns and anomalies providing early warning of potential attacks.

j. **Redundant Systems and Disaster Recovery Plans.** Disaster recovery plans outline procedures for restoring systems and data following an attack,

minimizing downtime and mitigating the impact on operations. By preparing for worst-case scenarios, the navy can enhance its resilience and maintain mission readiness.

k. **Encrypted and Secure Communication Channels.** Implementing end-to-end encryption for communication channels guarantees that data remains protected while being transmitted. By prioritizing encryption and secure communication, the navy can safeguard critical information and maintain operational security.

Figure 10: Options for Navy to Enhance Cyber Security



(Author’s Construction based on study)

Conclusion

As technological advancements continue to evolve, navy faces an increasing array of cyber threats that can compromise critical systems and infrastructure. The above discussion underscores the necessity for comprehensive cyber defence strategies, emphasizing that robust cyber security measures are essential for maintaining operational superiority in the battleground. Furthermore, it advocates for collaboration and the development of standardized cyber policies to address the global nature of these threats. Continuous investment in cyber training, education and innovative technologies are crucial for building resilient naval capabilities. Ultimately, cyber security is an operational priority in the digital age, integral to the effectiveness and security of the navy worldwide.

Cyber Security Enhancement Framework for navy encompass action plans that act as catalysts to prevent any type of cyber-attack. Analysis of various attack-vectors and statistics prove that navy has an incredibly challenging cyber environment. Cyber Criminals may have huge interest on the information possessed by navies. The network system and cyber environment of many developing navies is not so robust and general perception about the cyber environment reasonably lacks standard. More focus in the fields of cyber activities monitoring, training, device management, general knowledge on software usage and understanding policies are needed (Zheng, Yu, Li, Zheng, Xu, Xiaolong & Zhao, Qingzhan, 2022). In summary, ‘Cyber security’ provides a comprehensive overview of the subject for the informed general reader interested in understanding the dynamics of warfare, conflict, and security in the twenty-first century (Singer & Friedman, 2021).

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Biography of the Writer



Commander Mahbuba Afroze, (L), afwc, psc, BN was commissioned on 21 Dec 2001 in Electrical Branch. She completed his Network Manager Course from India and specialization from BNS SHAHEED MOAZZAM. She also did course on C802A SSM from 3rd Academy, Beijing, China. She has served onboard various ships, bases, BN Dockyard and NHQ in different capacities. Some of her appointments include GPE (L), Design Engineer and

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SECURING BANGLADESH NAVY IN THE AGE OF CYBER WARFARE : CHALLENGES AND STRATEGIES

Commander K M Nazrul Islam, (E), NGP, afwc, psc, BN

Abstract

Cyberspace is considered as the fifth domain of warfare after land, sea, air, and space domain. With the internet and digital technology now entrenched in daily life, cyberthreats has become increasingly a cause of concern for the world. Cybersecurity is also a matter of grave concern for Bangladesh Navy (BN) since BN has set its sights on the critical train of digital transformation. Automation and digital devices of naval ships and platforms may pose vulnerabilities and loopholes that can be manipulated and hacked by cybercriminals who are actively searching and attacking targets in order to achieve their objectives. Hence, BN needs to be prepared to face an increasingly complex and sophisticated cyber threat landscape. First of all, a comprehensive plan to be developed for quickly responding to and mitigating cyber incidents while minimising operational disruptions. Threats from the cyber domain do not respect geographical boundaries and will necessitate national and transnational coordination and collaboration for effective responses. Like Navies of USA, Malaysia, Singapore, South Korea and Indonesia, collaborating with national and international partners in cyber capacity enhancement, can lead to the creation of innovative solutions tailored to Bangladesh Navy's specific needs. Investing in modern cybersecurity technologies, such as AI-driven threat detection systems, blockchain for secure transactions, and encrypted communication channels, may protect BN from cyber threats. By staying ahead of the latest cybersecurity trends and implementing proactive measures to protect various systems, BN can reduce the risk of cyber-attacks and ensure the safety and security of important data and infrastructure. The journal provides a comprehensive overview of the challenges of cyber security threat and few recommendations for BN in navigating the digital sea.

Key Word: Cyber Warfare, Digitalisation, Cyber Security, AI, Cyber Threat

Introduction

The landscape of warfare has shifted today and the cyberspace is currently considered as the fifth realm of warfare after land, sea, air, and space¹. The exponential rise of worldwide online attacks and counter-threats has created new concerns for cyber warfare. Every day, millions of cyber-attacks of various sophistication attempt to target open networks. Physical confrontation may not emerge in the following days until a cyber-attack has been launched to cripple the lines of command, control, communication, and information². Cyberwarfare has the potential to bring a country's economy to a halt, making it an excellent weapon for delivering blows without engaging in a conventional conflict. More crucially, cyber-attacks can be launched practically from anywhere in the world³.

Bangladesh Navy (BN), like many other navies around the world, is also undergoing a digital transformation to stay competitive in the modern day. Consequently, cybersecurity has become a matter of grave concern for BN as it has set its sights on the critical train of digital transformation. With an increased reliance on digital technologies, the navy is also vulnerable to a rising array of cyber threats that could jeopardize operations and national security. The navy and the nation need to secure their own communications and ensure that connectivity is maintained and that all systems are accessible at all times. This article will look into the cyber warfare domain and cyber threat landscape, global trends of combatting cyber threat and few pertinent recommendations for Navy to combat these threats.

Aim

The aim of this paper is to discuss cyber security issues and strategies to be adopted by BN.

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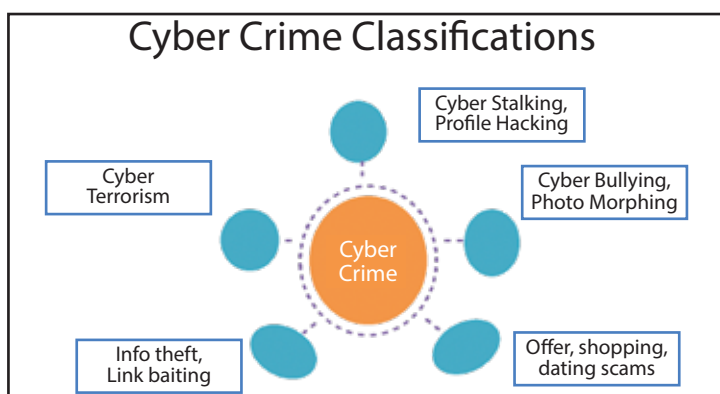
2. *ibid*.

3. Wing Commander M K Sharma, *Cyber Warfare- The Power of the Unseen*, New Delhi, KW Publishers Ltd, India, 2011, p6.

Conceptual Underpinning

Cybercrime. As Information and Communication Technology (ICT) becomes increasingly prevalent, cybercrime has become a common part of criminal behavior. Cybercrimes commonly take the form of denial of service, viruses, information tampering, cyberstalking, unlawful entrance, spamming, pager-jacking, dumping, phone-napping, and computer napping ⁴.

Figure 1: Various Forms of Cybercrimes



Source: Author's Construction

Hactivism. Hactivism combines political engagement and computer hacking. Hactivists are competent hackers whose operations range from exposing their targets through website defacements to complete economic sabotage⁵.

Cyberterrorism. It goes beyond 'Hactivism' by deliberately attempting to hurt and destroy⁶.

Cyber Conflict. This refers to the use of computing technology in cyberspace for malicious or harmful aims, such as influencing diplomatic or military relations⁷.

4. Atul Jain, *Cyber Crime- Issues Threat and Management*, New-Delhi, Isha Publications, 2015, p.4.

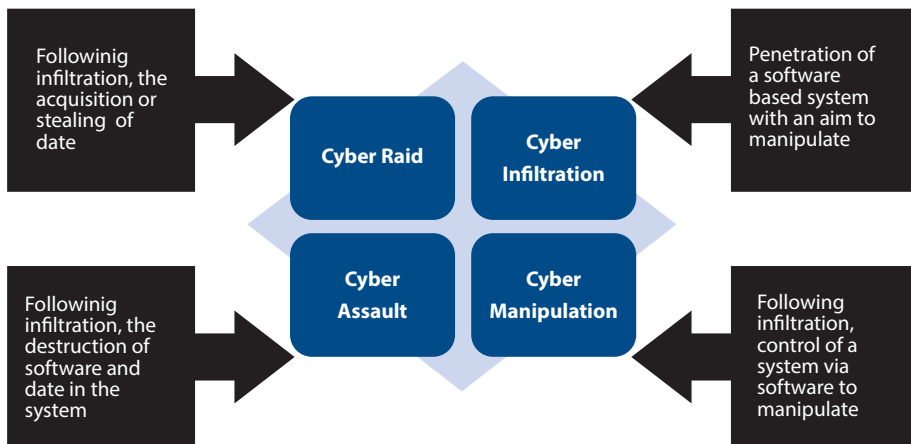
5. *ibid*.

6. *ibid*.

7. Anthony Craig and Dr Brandon Valeriano, 'Conceptualising Cyber Arms Races', Cardiff University 2016 8th International Conference on Cyber Conflict, Cyber Power, 2016.

Cyberwarfare. Cyberwarfare is when one country uses computer technology to purposefully disrupt another state's ICT systems for strategic, political or military purposes⁸. Cyberwarfare has similar goals to cyberterrorism; however, the participants are no longer terrorist organizations, but rather sovereign governments. It has a lot of appeal since it allows one country to attack another without risking their lives. Smaller states with little resources perceive cyberwarfare as a low-cost means of competing with other states⁹.

Figure 2: Cyber Warfare: Mode of Cyber Attack



Source: Cyber Crime- Issues ,Threat and Management by Atul Jain ¹⁰

Cyber Security. It refers to the process of protecting information and communication systems from harm, unauthorized use, and exploitation¹¹.

8. MG Mahmud, 'Cyber Forces Gain Traction in Southeast Asia', Asian Defence Journal, October 2023, pp. 14-17.

9. Book: Cyber Crime- Issues Threat and Management by Atul Jain, 2015, Isha Publications, New-Delhi, page 123).

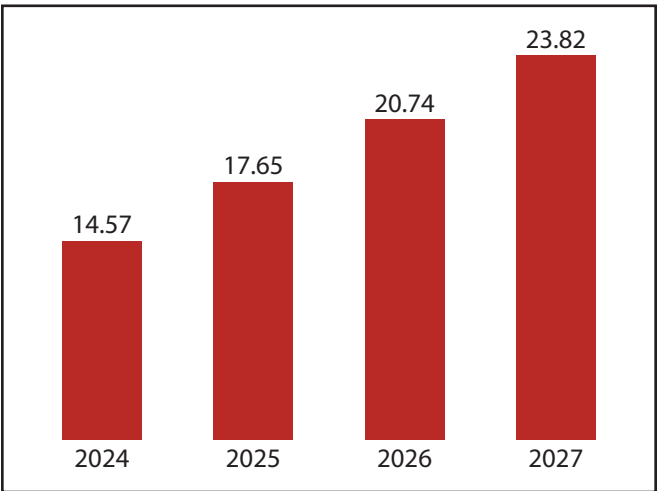
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Understanding Threat Landscape

Cyber security is seen as one of the most important national security challenges of present time, and it is increasingly being presented as a strategic-military concern¹². Major nations are creating new and more advanced military technology to maintain strategic superiority in areas like outer space and cyberspace¹³. Many non-state actors have demonstrated the power of digital technology to have an impact on the military domain, which is now the primary justification for establishing restrictions regulating individuals' behavior in the global network¹⁴. The probable global cost of cybercrime in the coming years is appended below, allowing all the relevant stakeholders to understand deeply regarding the cause of concern of cybercrime for Bangladesh.

Graph 1 : Estimated Cost of Cybercrime Worldwide (Trillion USD)



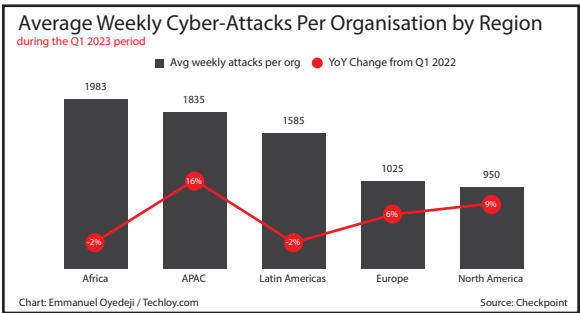
Source : Statista Technology Market Outlook, National Security Cyber Outlook, IMF ¹⁵

12. Myriam Dunn, 'The Militarisation of Cyberspace', Conference: Cyber Conflict (CYCON), 2012 4th International Conference, January 2012 .
13. *ibid.*
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The Rising Tide of Cyber Attacks and Statistics

The cyber-attack worldwide is increasing and it has become a global problem. The following graph will depict the rising tide of cyber-attacks worldwide:

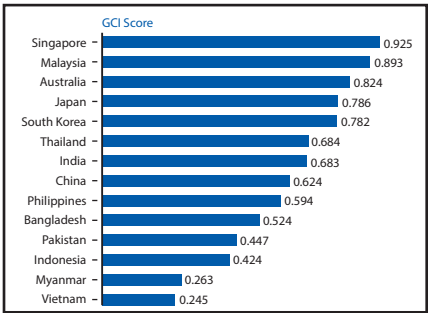
Graph 2 : Average Weekly Cyber-Attacks Per Organisation by Region



Source : Checkpoint, Chart- Emmanuel Oyediji / Techloy.com¹⁶

Global cybercrime is predicted to cost \$10.5 trillion annually by 2025, a substantial increase from \$3 trillion in 2015¹⁷. This astonishing surge highlights the critical necessity for effective cybersecurity measures. The global security index will help all concern to comprehend the position of Asia-Pacific countries in terms of cyber security.

Graph 3 : Global Cybersecurity index: Ranking of Asia-Pacific Countries



Source: www.researchgate.net/figure/Global-Cybersecurity-index-Ranking-of-Asia-Pacific-18

16. ‘Checkpoint Chart- Emmanuel Oyediji’, ‘Average Weekly Cyber-Attacks Per Organisation by Region ’ available at: www.techloy.com, accessed on 17 July 2024.

17. MG Mahmud, ‘Cyber Forces Gain Traction in Southeast Asia’, Asian Defence Journal, October 2023, pp. 14-17.

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Case Studies

Rome Lab, New York (1994). In March 1994, hackers were 'phreaking' across Columbia and Chile to New York, scamming telephone companies and the New York ISP to target Rome Lab¹⁹.

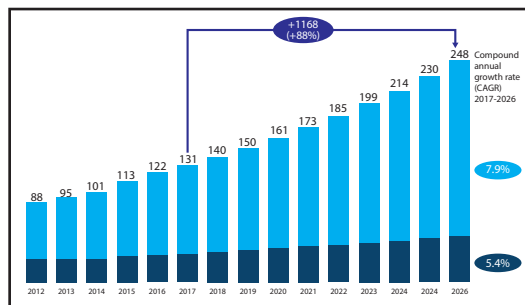
Kosovo War (1995). On 15 May, 1999, USA attacked on two Serbian industrial facilities. Prior to the operation, US and British information warfare professionals warned plant owners of the impending attack by e-mail, fax, and mobile phone. This covert operation namely 'Dubbed Matrix' shows the bright example of combining cyber war tactics²⁰.

Estonian Crisis (2007). In 2007, Estonian computerized infrastructure began to fray, victimized by 'Denial of Service' - a form of cyber-attack²¹.

World Military Trends in Cyber Domain

It is estimated that all of the world's top military expenditure countries are developing cyber offensive and defense capabilities. Many countries' armed forces are actively engaged in cyber defense and offense, incorporating cyber warfare into military planning and organization²². The following graphical representation may help to comprehend the increase in global spending for cybersecurity:

Graph 4: Global Increase in Cybersecurity Spending from 2012 to 2026



Source : <https://www.researchgate.net/figure/Global-increase-in-cybersecurity-spending-from-2012-to-2026-Source-AustCyber-nd>²³

19. Wing Commander M K Sharma, *Cyber Warfare- The Power of the Unseen*, New Delhi, KW Publishers Ltd, India, 2011, p.4.

20. *ibid*, p.5.

21. *ibid*, p.5.

22. MG Mahmud, 'Cyber Forces Gain Traction in Southeast Asia', *Asian Defence Journal*, October 2023, p. 14.

23. 'Global increase in Cybersecurity Spending from 2012 to 2026' available at: <https://www.researchgate.net/figure/Global-increase-in-cybersecurity-spending-from-2012-to-2026-Source-AustCyber-nd>, accessed on 12 July 2024.

USA

The developed countries, led by the United States, have implemented comprehensive cyber-warfare policies and strategies that make full use of advanced information technology. They are also boosting the pace of cyber force development and cyber-warfare research²⁴. The US Navy's first cyber strategy document, released on November 21, warned that the navy and Marine Corps "cannot rely exclusively on traditional naval power in future maritime conflicts" and must "fully account for new realities presented by cyberspace and the information environment."²⁵ "The US Navy employs digital engineering and cloud computing to incorporate and maintain resilience, allowing systems-of-systems to "work hurt," meaning they can resume operations. The US Navy use Model-Based Systems Engineering (MBSE) in conjunction with integrated threat information and system vulnerability data, as well as operational threat modeling, to keep ships mission-ready in the face of cyberattacks²⁶. The US Navy's cloud computing platform helps it to maintain operating tempo, maximize availability and avoid mission disruptions²⁷.

Lessons for Bangladesh from US Strategy. Bangladesh may benefit substantially from the United States National Cybersecurity Strategy which was released on March 2, 2023. Important takeaways from this strategy for developing countries like Bangladesh may include the need for a collaborative and holistic approach to cybersecurity, strong leadership and governance frameworks, funding for cybersecurity awareness and education and a focused effort to secure critical infrastructure²⁸. The plan stressed the importance of collaboration amongst several

24. MG Mahmud, 'Cyber Forces Gain Traction in Southeast Asia', Asian Defence Journal, October 2023, pp. 14-17.

25. 'US Navy's First Cyber Strategy Document' available at : <https://www.nextgov.com/cybersecurity/2023/11/navys-first-cyber-strategy-looks-beyond-cybersecurity-digital-operations/392283>, accessed on 12 July 2024.

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27. *ibid*.

28. Abir Mazumder, 'From the United States to Bangladesh: Key Lessons for Developing A Robust National Cybersecurity Policy', The Daily Star, April 7, 2023.

sectors, including government, corporate groups, academia and foreign partners. The US National Cybersecurity Strategy emphasizes the need for a "whole-of-government" approach to cybersecurity, as well as the need of cybersecurity education and awareness. Last, but not least, the Bangladesh National Cybersecurity Strategy might benefit from a stronger emphasis on protecting the country's key infrastructure²⁹.

Russia

Russia is a significant worldwide actor that uses cyberspace. The country has made significant progress in the area of cybersecurity. Russia has been issuing official documents on the subject since the early 2000s, with a focus on cybersecurity. The 2013 publication "Russia's Foreign Policy Concept" provides critical information on network diplomacy³⁰.

Asian Countries

With cyberattacks, disinformation and misinformation on the rise, ASEAN's ten member states formed the 'ASEAN Defence Ministers Meeting Cybersecurity and Information Centre of Excellence (ACICE)'. The hub was first formed in June 2021, but its offices were opened in July 2018. The ASEAN Regional Forum (ARF), the ASEAN +3 East Asia Summit and the ASEAN Defence Ministers Meeting-Plus (ADMM-Plus) are important defense forums in ASEAN that prioritize practical collaboration. Among ASEAN countries, Singapore and Malaysia have particularly well-developed national emergency response networks that incorporate the private sector to a higher extent than other states in the region³¹.

Singapore

The Singapore Armed Forces and Intelligence Service built a division-sized force capable of successfully navigating cyber threats from overseas aggressors in

29. *ibid*.

30. 'Cyber Security Strategy of the Russian Federation' available at: <https://www.ankasam.org/cyber-security-strategy-of-the-russian-federation>, accessed on 11 July 2024.

31. MG Mahmud, 'Cyber Forces Gain Traction in Southeast Asia', *Asian Defence Journal*, October 2023, p. 16.

2022. Singapore has held three editions of Exercise Cyber Star since 2016, a national cyber crisis management exercise in which diverse sectors test their operational plans in response to complex simulated attacks³².

Malaysia

Malaysia established the 'Defence Cyber and Electromagnetic Division (DCED)' to strengthen its cyber and electromagnetic defences. The DCED exemplifies the Malaysian Armed Forces (MAF) commitment to remaining operationally ready to meet challenges in the electromagnetic and cybersecurity domains. The DCED is also the key agency at the MAF and Ministry of Defence, in charge of coordinating all cyber and electromagnetic domain activities³³. The DCED conducts internal exercises to strengthen MAF personnel's education and awareness of providing strategic communication and cyber defense services, such as 'Exercise Southern Communication'. Other joint exercises, such as 'Exercise Angsa' and 'Exercise Pahlawan', need the men and women of DCED to be constantly watchful in providing communication and command and control reach to all participants. DCED also participates in combined exercises such 'The Five Power Defence Arrangements', 'Exer Bersama Warrior' and 'Bersama Lima', Exercise Cobra Gold, and 'Exercise Cyber Endeavour'. All of the aforementioned exercises focus on preparing MAF's communication and cyber defences³⁴.

Japan

In 2014, Japan developed a Cyber Defence Group as part of its Self-Defense Forces. However, in response to an increasing number of cyber-attacks, it reorganized and established a full cyber defense command in March 2022, along with a pledge to engage in offensive cyber operations and intends to expand to 4,000 individuals by the end of 2027³⁵.

32. *ibid.*

33. Admiral Shamsuddin Ludin, RMN, Director General , Defence Cyber and Electro Magnetic Division, 'Asian Defence Journal', October 2023, ISSN 0126-6403, pp. 7-8.

34. *ibid.*

35. MG Mahmud, 'Cyber Forces Gain Traction in Southeast Asia', Asian Defence Journal, October 2023, pp. 14-17.

South Korea

South Korea released its first Cyber Strategy on 01 February 2024. The strategy has four main features: a focus on cyber threats emanating from North Korea, an offensive approach towards identifying and responding to attacks, expanding global cyber cooperation and establishing a rapid response system³⁶.

Digitalisation vis-à-vis Cyber Security Threat

Cybersecurity is predicted to evolve as technology progresses and cyber-attacks become more sophisticated³⁷. Bangladesh's digital journey has been characterized by many projects aimed at utilising technology to promote economic growth, better governance and enhance public services. The Journey is to create a shift, imagining a digitally empowered society in which information and communication technology (ICTs) play a central role in daily life. This exhilarating voyage into the digital era is plagued with a significant challenge, i.e. cybersecurity. The interconnected structure of digital systems magnifies the potential impact of cyber catastrophes, demanding proactive efforts to mitigate such risks. By 2024, artificial intelligence (AI) is predicted to be used in 30% of all cyberattacks³⁸.

Cyber Security in Naval Domain

The navy must deal with cyber threats both at sea and on shore. Even minor disruptions to supply lines or navigation systems can be extremely costly and have tremendous impact on naval operations. It is consequently critical to secure against cyber-attacks in naval workstations and network components, both on board ship and in port. Again, the maritime environment differs from standard IT environments in terms of physical constraints such as temperature, humidity and

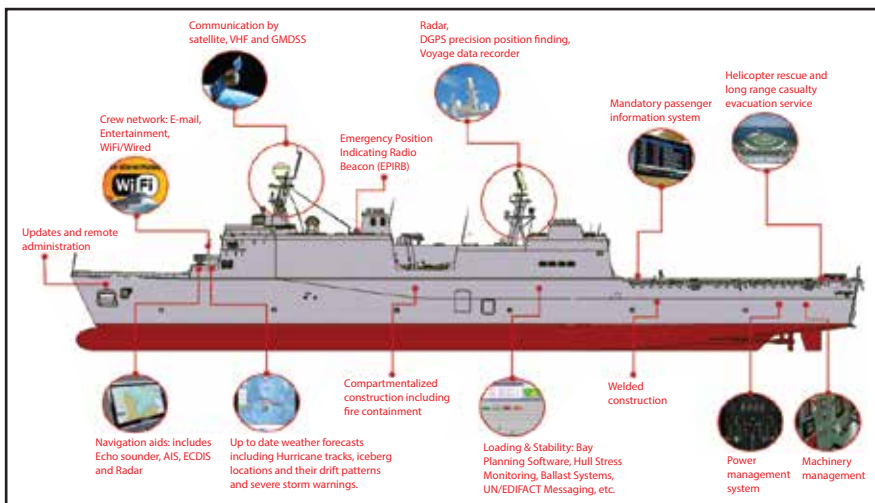
36. Sarbhanu Nath, 'New Cyber- Security Strategy Demonstrates South Korea's More Offensive Cyber Posture', *Janes Defence Weekly*, Vol 61, 28 February 2024, p. 17

37. Dr Amirudin Abdul Wahab, 'Strategies and Challenges in Managing Latest Cyber Security Challenges' *Asian Defence Journal*, October 2023, pp. 10-12

38. Nchumbeni Yanthan, 'Cyber-Attack Statistics and Trends' Published on 9 Aug 2023, available at : <https://www.sprintzeal.com/blog/cyber-attack-statistics-and-trends>, accessed on 12 July 2024

salinity. The objective is to install the security parts as close to the protected equipment as possible without using a computer rack. Cyber risks in the marine industry provide unique problems that require proactive solutions and ongoing attention. The interconnected structure of digital systems in naval ships, platforms and assets exposes vulnerabilities that malicious actors try to exploit. From phishing attacks on sailors to sophisticated cyber-espionage aimed at gaining essential data, Bangladesh Navy may face a variety of difficulties that may jeopardize overall security and operational readiness. Understanding these hazards is crucial for creating effective cybersecurity safeguards. The following figure may help everyone appreciate the vulnerability of digital and automated naval ships to cyber-attack:

Figure 3 : Modern and Autonomous Ship Vulnerable to Cyber Attack



Source : Cybersecurity Challenges in the Maritime Sector, Published on 7 March 2022 in the Special Issue of 'Advances on Networks and Cyber Security' by Frank Akpan,, Gueltoum Bendiab, Stavros Shiaeles , Stavros Karamperidis , Michalis Michaloliakos ³⁹

Cyber Security Strategies

Everyone is accountable for managing their own information, data and safety, as well as the safety of other people. Cybersecurity is no longer the responsibility

39. 'Cybersecurity Challenges in the Maritime Sector, 'Advances on Networks and Cyber Security' , 07 March 2022

of a single individual or the sole responsibility of the information technology department⁴⁰. Securing Bangladesh and Navy’s digital future is a collective responsibility. Recognising the severity of cyber threats, BN has a crucial role to play in enhancing cybersecurity measures. To safeguard its digital transformation, BN need to implement a robust cybersecurity framework encompassing various initiatives: raising awareness, investing in infrastructure, developing a skilled workforce and fostering innovation. This robust cyber security framework may create such a digital ecosystem which is secured and prosperous for BN. Bangladesh Navy needs to aware its personnel about nature and impact of cyber threat. For effective protection against cyber threat, BN may implement strategy like investment in robust cybersecurity infrastructure, fortifying databases, implementing strong firewalls and developing a culture of data security within organisations. Moreover, collaboration among BN and various public and private sectors is essential to create a comprehensive cyber security framework. Navy can contribute to cybersecurity capacity building through training programs, workshops and knowledge sharing initiatives. This helps to enhance the skills of cybersecurity professionals across various sectors. In 09 August 2023, Cyber security specialists Nchumbeni Yanthan has proposed ten ways to strengthen cybersecurity defenses, which may also be followed by BN :

Figure 4 : Ways to Strengthen Cybersecurity Defenses



Source : www.sprintzeal.com/blog/cyber-attack-statistics-and-trends ⁴¹

40. Dr Amirudin Abdul Wahab, ‘Strategies and Challenges in Managing Latest Cyver Security Challenges’ Asian Defence Journal, October 2023, pp. 10-12

41. Nchumbeni Yanthan, ‘Cyber-Attack Statistics and Trends’ Published on 9 Aug 2023, available at : <https://www.sprintzeal.com/blog/cyber-attack-statistics-and-trends>, accessed on 12 July 2024

Proposed Comprehensive Cyber Security Strategy for BN

Policy. A comprehensive cybersecurity policy needs to be developed by BN.

Awareness. Raising awareness and encouraging the creation of a cybersecurity culture in navy is very crucial. Campaigns and workshops can equip naval personnel with the tools to navigate the digital landscape safely.

Trusted Technology Provider. Working with a trusted technology provider for various services like antivirus software, cloud backup solutions etc. can help ensure naval systems are protected from cyber threats.

Cybersecurity Unit. A cybersecurity unit may be created to monitor and respond to cyber threats. A skilled cyber security workforce is crucial for ensuring cybersecurity. Naval personnel need to be trained on cyber warfare tactics and mitigation strategies for proactive threat detection and response. Specialised cybersecurity programmes need to be developed to strengthen cyber defences. Naval cybersecurity unit can provide a consistent approach to threat identification, incident response and risk management.

Adopt Security Solutions. Tools like firewalls, intrusion detection systems, and cutting-edge endpoint security need to be maintained and updated regularly. In addition, few other steps like segmenting networks to restrict access to important regions for minimising attack surfaces, implementing strong endpoint security measures, including antivirus software and firewalls and encrypting important data to protect against unauthorised access need to be considered.

Security Tools. AI-powered security tools can be used to find and address threats in real time. Investment in cybersecurity technology like intrusion detection systems and threat intelligence platforms may be considered.

Perform Regular Security Audits and Penetration Testing. Regular security audits and penetration testing need to be conducted which helps identify weaknesses in the systems and allows proactive measure against cyber attack.

Incident Response Plan. An efficient Incident Response Plan can be created by devising a complete management plan for navigating cyberattacks smoothly. This will mitigate the effects and promote a speedy recovery.

Collaboration. A collaborative approach based on information sharing and joint projects across government agencies, the Navy, academia and the business community will result in a more cohesive response to cyber threats. Countries such as Singapore, Malaysia, Indonesia, South Korea, the United States and Australia have chosen a collaborative approach to creating their cyber security architecture. For example, 'Cyber Security Malaysia' collaborates with a wide range of stakeholders, including government agencies, industry players and the general public, to raise cybersecurity awareness, establish cybersecurity standards and guidelines, conduct research and development, and provide incident response services⁴². Sharing information and best practices with friendly navies around the world strengthens the collective defense against cyber threats. Australia has been partnering with the United States and other allies to bolster cyber-defense capabilities⁴³. Thus, engaging in international collaborations and partnerships may likely enhance Bangladesh's cybersecurity posture by leveraging global best practices, threat intelligence sharing and collaborative defense initiatives.

Employing the Geek and Nerds. To combat cyber threats, a purely military approach may not be effective and as such a strong civilian front is crucial for long-term success.

Recommendations

The followings are recommended :

- Efforts may be taken by BN to design a detailed cybersecurity strategy including capacity development roadmaps, cyber duties, incident response strategies for dealing with cyber-attacks, and implementing cyber auditing policies to detect risks and compliance issues.

- Efforts may be made by BN to enhance cyber- security capacity by creating a dedicated cybersecurity unit to detect and respond to cyber threats.
- BN may consider investing in robust cybersecurity technologies, such as intrusion detection systems and threat intelligence platforms.

Conclusion

The ever-changing strategies and escalating level of complexity of cyberwarfare make it a major concern. Bangladesh may need to work comprehensively to defend its cyberspace and protect critical information, infrastructure resulting in a secure digital environment for armed forces, individuals, enterprises and other government body. By implementing robust cybersecurity measures and adopting proactive defense strategies, a safer and more secure digital environment can be created. Bangladesh Navy can secure its place in the digital age by embracing a proactive approach to cybersecurity. This journey necessitates not only investment in technology, but also the development of a culture of cyber awareness and collaboration. The navy and the nation can be better prepared to deal with cyber threats if they keep up with the latest trends.

The navy's journey in securing its digital transformation against cyber threats is a testament to its determination. To maintain a competitive edge in maritime security, Bangladesh Navy must remain committed to evolving its cybersecurity posture, adapting to new challenges and leveraging innovation. Navigating the digital sea is a complex challenge that requires a comprehensive approach to cybersecurity. A collaborative strategy is to be considered taking armed forces, government agencies, industry players and academia on board in order to raise cybersecurity awareness, establish cybersecurity standards and guidelines, conduct research and development, and provide incident response services. Bangladesh Navy can mitigate cyber threats by implementing strong cybersecurity measures such as risk management, network segmentation, endpoint security, encryption, incident response, cybersecurity awareness training and collaboration with academia, sister services, government and industry partners.

Biography of the Writer



Commander K M Nazrul Islam, (E), NGP, afwc psc, BN was commissioned on 24 June 2002. He has completed his 'Marine Engineering Specialization Course' from BNS SHAHEED MOAZZAM, Kaptai, Chattagram 2012. He has attended Junior Staff Course at the Bangladesh Naval Academy in 2011. He has done the 'Officers Bomb and IED course' from Bangladesh Army in 2009. The officer has served onboard various ships and bases of the Bangladesh Navy in different capacities. Some of the key appointments include 'Deputy Director of Shipbuilding' at Naval Headquarters, Staff Officer to 'Director of Technical Stores' at Naval Headquarters, 'Deputy General Manager' at BN Dockyard, Engineer Officer of BNS SANGRAM, SHADHINOTA, PROTOY, DURJOY, NIRMUL, TISTA, MOHIBULLAH etc. The officer took part in UN mission onboard BNS NIRMUL as Engineer Officer in UNIFIL, Lebanon. He is happily married and blessed with a son and a daughter.

CHARTING A COURSE TO PROSPERITY UNLOCKING BANGLADESH'S BLUE ECONOMY WITH HYDROGRAPHIC DATA

Commander Md Yousuf Ali, (H1), psc, BN

Abstract

Bangladesh, has successfully settled its maritime boundary with both the neighbours and gained huge maritime territory, which is progressively recognizing the potential for blue economy initiatives. For harnessing this potential including exploration, exploitation of marine resources for sustainable development with economic prosperity hydrographic data is paramount. Hydrographic data which provides critical and crucial information on the oceanic and coastal environments is the prime mover of Blue Economy initiatives. This writes up will explore the pivotal role of hydrographic data in unlocking Bangladesh's blue economy. It will also examine precise mapping of seabed topography, ocean currents, waves, direction including surface topography and coastal dynamics for decision making in various sectors such as marine transportation, fisheries management, offshore energy exploration, and coastal infrastructure development. Moreover, the integration of advanced technologies in hydrography like satellite derived bathymetry, remote sensing, unmanned surface survey vehicles and autonomous underwater survey vehicles enhances the precision and accuracy level of hydrographic data. The precise and accurate hydrographic data stock is playing a vital role for comprehensive planning and resource management in the field of Blue Economy. By capitalizing the comprehensive hydrographic data and information with the international collaborations, Bangladesh can effectively influence its maritime resources ensuring environmental sustainability and resilience against natural calamities and climate change impacts. This abstract advocate a pathway that spots hydrographic data as a foundation in charting Bangladesh's course towards a prosperous and sustainable blue economy.

Introduction

Bangladesh entered into Blue Economy era after the Maritime boundary delimitation with both the neighbours. Bangladesh achieved a huge area (1,18,813 Sq Km¹) in the Bay of Bengal which is almost equal to land territory. As the land resources are saturated, so it is the best time to explore and exploit maritime resources from the sea. With this moto, Bangladesh government has identified total 26² potential sectors in the field of Blue Economy which will lead Bangladesh to emerge as a developed country. To explore all these potential sectors seismic survey and precise hydrographic data plays a vital role.

The primary purpose of hydrographic data is to ensure safety of navigation and to support all other marine activities, including economic development, security and defense, scientific research, marine biodiversity, climate change impact assessment and environmental protection³. Generally, hydrographic data is used for producing nautical charts for safe navigation for the mariners including commercial transportation.

In addition, hydrographic information is essential for the marine biodiversity, exploration and exploitation of marine resources, safe, efficient and sustainable conduct of every human activity that takes place above surface, surface sub-surface or beneath the sea. In order to promote Blue Economizing initiatives and for sustainable development reliable and accurate data is paramount. Any maritime infrastructure in the coastal and off shore areas demand valued hydrographic information. The relationship between hydrographic data and enhancing the blue economy is deep-rooted because of accurate, precise and comprehensive marine information. Thereby, hydrographic data is critical and crucial for Blue Economy sectors that directly contribute to the sustainable development of Bangladesh.

1. Bangladesh gazette (extraordinary) Cabinet division on Sunday, July 20, 2014.

2. Blue Economy Cell, Energy and Mineral Resources Division (2022), Blue Economy and Bangladesh Government (2017-2021).

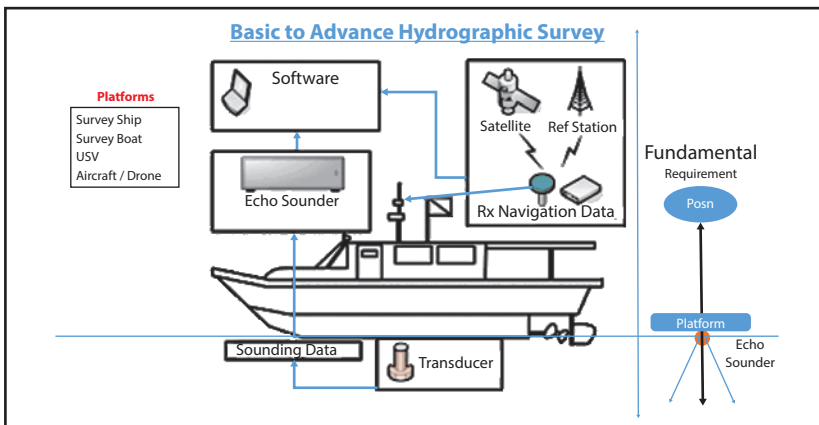
3. <https://iho.int/en/what-is-hydrography>.

What is Hydrography and Blue Economy in Reality?

As per International Hydrographic Organization, Hydrography is the branch of applied science which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time⁴.

Hydrography encompasses measuring the depth of the water including fixing the position with time tag of all the navigational hazards that lie on the seafloor, such as wrecks and rocks. This examination is carrying out mainly with specialized ships and boats fitted with echo sounders, Global Navigation Satellite System (GNSS) and sonars. This action can be done using survey aircraft fitted with lasers. Sometimes useful data can also be derived from satellite observations. Hydrography also involves measuring the tide and the currents with other many activities.

Figure 1 : Basic to Advanced Hydrographic Survey (Symbolic picture)



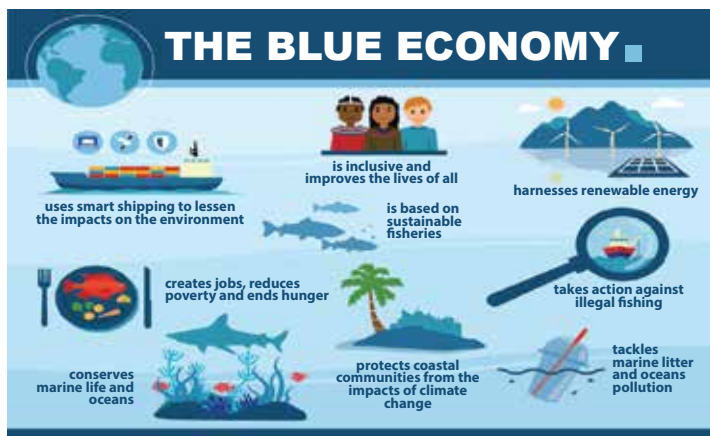
Source : (Author created)

The concept of Blue Economy is still at a developing stage and yet to develop a comprehensive definition which would be appropriate from the operational view point. In some literature, Blue Economy has been used various synonym like; 'Marine Economy', 'Coastal Economy', 'Ocean Economy', 'Green Economy' and so on. According to the World Bank, Blue Economy is the "sustainable use of ocean

4. <https://iho.int/en/what-is-hydrography> ibid

resources for economic growth, improved livelihoods and jobs while preserving the health of ocean ecosystem⁵”.

Figure 2 : Sustainable Blue Economy⁶



Source : <https://www.nyikasilika.org/what-you-need-to-know-about-the-sustainable-blue-economy-y-conference>

Bangladesh’s blue economy offers enormous opportunities for sustainable, clean, equitable blue growth in both traditional and emerging sectors⁷. Bangladesh government has identified total 26 potential sectors in the field of Blue Economy which will lead Bangladesh to emerge as a developed country. Few of these potential sectors are; Marine Navigation and Safety, Marine Environmental Protection, Off Shore Energy, Fisheries and Aquaculture, Coastal Zone Management, Submarine Cable and Pipeline laying, Marine Spatial Planning, Tourism and Recreation and so on.

Unlocking Bangladesh’s Blue Economy with Hydrographic Data

After the settlement of maritime boundary with the neighbours Bangladesh has achieved a vast maritime area with full of marine resources including oil and

5. <https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy>

6. <https://www.nyikasilika.org/what-you-need-to-know-about-the-sustainable-blue-economy-conference>

7. mofa.gov.bd /BLUE ECONOMY –Development of Sea Resources for Bangladesh by Rear Admiral Md. Khurshed Alam (Retd)

gas. As the land resources are saturated, focus has been shifted towards sea for extraction of potential resources for sustainable development of Bangladesh. In this note, hydrographic data is equally important for implementing the potential blue economy sectors which will lead Bangladesh to emerge as a developed country. The emerging sectors of Blue Economy where hydrographic data plays a key role are appended below:

Figure 3 : Potential Blue Economy sectors of Bangladesh



Source : (Author created)

Marine Navigation and Safety : There is no alternatives other than hydrographic data for creating and updating nautical charts, ensuring safe navigation for warships, commercial shipping, fishing vessels, tourist boat and any other recreational boating. There is a saying that, “no survey no navigation, No data no movement”. Thereby, hydrographic data is of paramount importance. Hydrography plays a pivotal role in enhancing maritime transportation, Navigational safety, identify and locate hazardous objects, wrecks, underwater obstacles etc. Supporting all these marine activities is equal to support Blue Economy.

Figure 4: Marine Navigation and Safe Anchorage Area at Outer Anchorage Chittagram



<https://dailyasianage.com/news/29304/52-mother-vessels-waiting-at-outer-anchorage-of-ctg-port> and <https://www.daily-sun.com/post/229902/Chittagong-Port-activities-halted-as-Cyclone-Mora-approaches-Bangladesh-coast>

Marine Environmental Protection : Grab samples used to take to determine the baseline diversity of fauna, the presence and importance of indicator species, and the effects of any apparent organic pollution within the area⁸. Hydrographic data is also applied to monitor and managing marine ecosystems, understanding seabed habitats and assessing the impacts of human activities on the marine environment. All these information is the key tool for enhancing Blue Economy potentials. Thereby, Hydrographic data is supporting Blue Economy in manyfold.

Figure 5 : Marine Biodiversity



Source : BANGLADESH NATIONAL CONSERVATION STRATEGY, Page no-7,
[https://bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/notices/c3379d22_ee62_4dec_9e29_75171074d885/Executive%20Summary\(NCS\).pdf](https://bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/notices/c3379d22_ee62_4dec_9e29_75171074d885/Executive%20Summary(NCS).pdf)

8. https://epawebapp.epa.ie/licences/lic_eDMS/090151b28024f4d5.pdf

Offshore Energy : Precise Hydrographic data is required to support the planning, construction and maintenance of offshore installations like, oil, gas and renewable energy installations such as wind farms and tidal energy sites⁹. To install off shore installation it is essential to know the bottom characteristics, sediment thickness of particular area, direction of current, wave height, water clarity including many other factors of water column. Otherwise, sustainable development is not possible. Here also hydrographic data is also the key factor.

Figure 6 : Windmills/ Wind farm (Puratan Shanti Bazar in Cox's Bazar's Kutubdia Island.
Photo: Rashed Shumon)



Source : <https://www.thedailystar.net/opinion/no-frills/news/we-have-wind-power-1659580>

Fishes and Aquaculture : The information about fishes and aquaculture lies with hydrographers and oceanographers. Actually, it depends on seabed topography, water clarity, water depth and ocean currents. All these information assists in locating potential fishing grounds and aquaculture sites including productivity and sustainability. Bangladesh Navy Hydrographic Department already has published two special charts for fisherman, locating the potential fishing ground Marine Reserve Area (MRA) and Marine Protected Area (MPA).

9. Source : <http://stream1.cmatc.cn/pub/comet/MarineMeteorologyOceans/IntroductiontoHydrography/comet/oceans/hydrography>

Figure 7 : Aquaculture and fish farming



Source : <https://www.addressbazar.com/agricultural-products-service/aquaculture-fish-farming>

Coastal Zone Management : The Coastal Zone Management (CZM) is a procedure that consists legal and institutional outline to ensure development and management plans for coastal zones integrated with environmental and social goals. The affected people will be integrated in this process for their development¹⁰. Hydrographic data and information will play a significant role in the management and development of coastal areas, beach nourishment and the design of coastal infrastructure, development of beach embankment, identify the low laying areas including rate of erosion and erosion control. Thereby, Hydrographic data and information is the prime requirement for CZM.

Marine Spatial Planning (MSP) : MSP will help in decision making with comprehensive spatial data, to enhance collaboration amongst various stakeholders, Sustainable development by incorporating data on protected species, sensitive habitats, and cultural resources into planning efforts, Resilience to Future Challenges by identifying data gaps¹¹. Without hydrographic data MSP is not possible. All these hydrographic data will support the allocation of marine resources and space, balancing the needs of different sectors and minimizing conflicts between users. At present MSP is the core value for Blue Economy harnessing as well as nation's development.

10. Coastal Zone Management- Purpose, Objective and Challenges- by Jagran Josh, 14 Feb 2019

11. <https://coastalscience.noaa.gov/project/marine-spatial-planning-data-development-u-s-caribbean/>

Submarine Cable and Pipeline Laying : The special vessel is required to fix Submarine Cable and Pipeline Laying in the deep ocean. Interesting fact is that, the cable ship is equipped with equipment for geological and oceanographic surveys for the purpose of laying and maintaining operations¹². **Hydrographic surveys provide critical and crucial data for the exact location, safe routing and installation of underwater cables and pipelines.** Because it demands secure laid in the ground and stable location including the bottom topography of sea bed. Here hydrographic data is the prime mover and the Submarine Cables and Pipeline is one of the focused elements of Blue Economy.

Figure 8 : Submarine Cables and Pipeline Laying (Symbolic Picture)



Source:<https://www.linkedin.com/pulse/submarine-cables-worldwide-internet-telecommunication-data-center>

Tourism and Recreation : Tourism and Recreation is one of the most promising sectors for Blue Economy initiatives. Furthermore, detailed maps, specific location and data on coastal and underwater features enhance tourism activities such as diving, snorkeling, and marine wildlife tours. Here, hydrographic data is playing a significant role to identify the under-water features, bottom topography and suitable area for diving and snorkeling.

12. Submarine Cables for Worldwide Internet and Telecommunication by Padjadjaran Oceanographic Data Center, Published on 19 Sep 2012

Figure 9 : Scuba diving and Snorkeling at St Martins



Source : <https://www.dhakaholidays.com/scuba-diving-saint-martin-bangladesh>

Figure 10 : Turism and Recreation at St. Martins



Source : St. Martin's Island & Chera Island- by Afsana Meme on 04 Aug 2020

Disaster Risk Reduction and Management : Disaster risk reduction and management of disaster-prone area also require appropriate hydrographic data. Hydrographic data is used in predicting and mitigating the impacts of natural disasters such as tsunamis, hurricanes and storm surges etc. Hydrographic data and information help to minimize the damage of coastal communities and infrastructure from any natural disaster.

Figure 11 : Disaster Risk Reduction and Management Circle.



Source: disaster management in BD: Risk reduction and Challenges-
by Sajid Karim (BISS) on 08 Sep 2015

Uses of Hydrographic Data by Bangladesh, Littorals and Regional Countries in Unlocking Blue Potentials

Bangladesh, Littorals and Regional countries are formulating a broad concept for harnessing Blue Economy using Hydrographic data. The blue economy is for sustainable use of ocean resources for economic growth, improved livelihoods and nation building activities maintaining ocean ecosystems. Comparatives of using Hydrographic data by states are:

Table 1 : Comparative uses of Hydrographic data in BE potentials

SL	Country	Using Hydrographic Data for Unlocking BE Potential
1.	Bangladesh	Marine Navigation and Safety, Marine Environmental Protection, Off Shore Energy, Fisheries and Aquaculture, Coastal Zone Management, Submarine Cable and Pipeline laying, Marine Spatial Planning, Tourism and Recreation.
2.	India	Marine Navigation, Resource Management, Disaster Management, water transport, fishery & aquaculture, mineral exploration, coastal management & governance, Shipbuilding and shipping ¹³ .

13. India's Blue Economy Potential & Draft Policy Framework- by Anusha Arif on Apr 30, 2024

SL	Country	Using Hydrographic Data for Unlocking BE Potential
3.	Australia	Marine Spatial Planning, Offshore Energy, Tourism, Environmental Monitoring, renewable energy, aquaculture, seabed extractive activities and marine biotechnology ¹⁴ .
4.	Indonesia	Fisheries Management, Maritime Transport, Disaster Response, Marine Conservation.
5.	South Africa	Port Development, Marine Resource Exploration, Coastal Protection, Tourism and Recreation.
6.	Kenya	Blue Economy Initiatives, Infrastructure Development, Environmental Conservation, Climate Change Adaptation.
7.	Sri Lanka	Maritime Safety, Disaster Risk Reduction, Resource Management, Tourism Development.
8.	Oman	Port and Harbor Management, Marine Resource Exploration, Environmental Protection, Coastal Development.

Challenges of using Hydrographic Data while Unlocking Bangladesh's Blue Economy

There are several challenges while Unlocking Bangladesh's blue economy with hydrographic data. As per International Hydrographic Organization (IHO) the hydrographic data has to be qualified few standards before producing hydrographic product. that need to be addressed to ensure successful implementation and sustainable growth. Here are the key challenges:

- a. **Data Collection and Quality.** BN has five survey vessels including BNS ANUSHANDHAN. Except ANUSHANDHAN, PCs and shallow draft smaller crafts were installed with survey equipment and carry out the survey activities. As per the International Hydrographic Organization (IHO) the data should be very specific, focused, accurate, reliable and has to meet various standards.
- b. **Updating Data on Regular Basis.** Due to huge maritime areas it is very difficult to update all the data every time with limited resources. Furthermore, the indented coast demands very precise, updated and comprehensive data to enhance maritime safety.

14. https://www.google.com/search?q=In+which+sectors+Australia+is+using+hydrographic+data+for+harnessing+blue+economy&sca_esv

c. **Data Management and Sharing** : There is no central portal or data stowage for data sharing amongst the maritime stakeholders and other agencies. In Bangladesh there are few agencies and organizations like, BN, BIWTA, Maritime Ports (Within Port limit) usually carry out hydrographic survey. Different formats and standards used by various agencies is also another challenge for data sharing and integration. Thereby, less integration hinders the chance to accumulate the actual data and may hamper the Blue Economy initiatives.

d. **Capacity Building** : There is a shortage of hydrographers and technical experts in modern survey techniques comparatives of total tasking.

e. **Policy and Regulatory Framework** : As there is no National Hydrographer for the government of Bangladesh, no comprehensive national hydrographic policy and regulatory framework to guide data collection and usage amongst stakeholders. Furthermore, coordination among various government agencies and stakeholders is often time consuming.

f. **Technological Challenges** : Now a days technology is changing rapidly and very difficult to keep pace with the modern inventions. Thereby, adoption with the new technology takes time and sometime it is little challenging to carry out proper hydrographic survey.

g. **Environmental and Geographical Challenges** : Country like Bangladesh is always facing the hard core of natural disaster like, Cyclone, storm surge, flooding etc. In addition, Bay of Bangle gets choppy almost two third of the year. Thereby, hydrographic survey is not possible round the year. Furthermore, rapid changes in coastal and marine environments require continuous updates to hydrographic data, posing a significant challenge.

h. **Stakeholder Engagement and General Awareness** : Engaging diverse stakeholders including government, private sector, academia and local communities in hydrographic activities in a coordinated manner is a big challenge. Awareness among local communities and industries about the

importance of hydrographic data and the blue economy is also another limitation.

Charting a Course to Overcome the Challenges for Unlocking Bangladesh's Blue Economy with Hydrographic Data

For charting a course to unlock Blue Economy potentials for the prosperity of Bangladesh with Hydrographic data we need to overcome the above stated challenges. To get the pathways for harnessing Blue Economy of Bangladesh through the use of hydrographic data a multifaceted approach is required. Few strategies to address each of the identified challenges are appended below:

a. **Enhancing Data Collection and Quality** : To keep pace with modern hydrographic equipment and technology it is necessary to procure state-of-the-art hydrographic survey vessels, equipment and technology such as modern multibeam echo sounders, LiDAR, Autonomous Underwater Survey Vehicles (AUVs), and Uncrewed Surface Survey System etc. to enhance data quality.

b. **Improving Data Management and Sharing** : BN may develop a centralized, integrated hydrographic data management system. In addition to establish MSDI, BN may take initiatives among stakeholders, so that hydrographic data may be used widely for unlocking BE potentials in BD. BN also may take lead role to use the standardized formats and protocols for data collection for the other maritime stakeholders and ensure interoperability. Furthermore, BN may formulate policies that promote open access to hydrographic data for researchers, policymakers and industry stakeholders. Thereby, collectively it will be easier to unlock the BE potentials in BD.

c. **Capacity Building** : To grow up expertise in the state-of-the-art equipment including hydrographic and marine data management need to establish training programs in collaboration with universities, Industrial stakeholders, Maritime stakeholders and international organizations.

Various workshops, seminars, and conferences to be organized to disseminate knowledge and best practices among the stake holders. Advanced hydrographic courses and exchange programs for related studies in hydrography may be offered to learn the uses of hydrographic data in unlocking BE potentials of Bangladesh.

d. Addressing Environmental and Geographical Challenges : BN is carrying out annual survey for updating the existing charts and to ensure navigational safety in the maritime domain including the coastal areas. BN may incorporate disaster resilience into hydrographic survey planning to minimize disruptions.

e. Promoting Sustainability : Promoting sustainable fishing, tourism and resource extraction practices will lead BD to sustainable development. BN has already published Two Special fishing charts indicating the most probable fishing zones including Marine Reserve and Marine Protected Area for fishermen. Now it is required to enforce marine protected and reserve areas to conserve critical habitats and biodiversity. Align blue economy initiatives with the United Nations Sustainable Development Goals (SDGs) including proper monitoring, regulating and imposing the restrictions and updating the fishing charts by hydrographic department will lead Bangladesh to unlock the BE potentials.

f. Awareness Campaigns : It is high time to make general awareness about Blue Economy potentials and importance of hydrographic data in regards through launching public awareness campaigns to educate communities and industry stakeholders. Establish forums and platforms for regular dialogue and collaboration among stakeholders.

g. Fostering International and Bilateral Collaboration : Mutual cooperation and coordinated agreements, MOU with neighboring countries and littorals for sharing management of marine resources and data which will help to unlock the Blue Economy potentials of Bangladesh.

Conclusion

After the maritime boundary delimitation with both the neighbours a general consciousness has grown up about the ocean and its economic use. The Bay of Bengal plays a significant role for our maritime transportation along with economic activities. The vast maritime areas in the Bay of Bengal are full of living and non-living natural resources. The government has taken a deep initiative to explore and exploit natural resources for economic growth for sustainable development. Thereby, government has formulated a comprehensive Blue Economy initiative for unlocking blue potentials from Bay of Bengal.

The relationship between hydrographic data and harnessing the blue economy potential is inter connected because of accurate, precise and comprehensive marine information. Without hydrographic data it is not possible to develop and carry out economic activities within the ocean and coastal zones. On the contrary, hydrographic data provides the foundational information necessary for safe, efficient, resilient and sustainable exploitation-exploitation and conservation of marine resources, directly contributing to the growth and enhancement of the blue economy.

In the Bay of Bengal not only Bangladesh but also the, littorals and regional states are leveraging hydrographic data in various ways to unlock their blue economies. Hydrographic data are used in all the blue potentials like ensuring maritime safety, supporting sustainable resource management, fostering coastal and marine tourism, governing off shore energy, conserving biodiversity and protecting marine environments. In the coastal areas Bangladesh is establishing huge maritime infrastructure for unlocking Blue Economy for sustainable development using hydrographic information precisely, effectively and sensibly. Bangladesh is going to balance economic growth with environmental sustainability, contributing to the overall prosperity and resilience of the coastal communities through charting a course to unlock Bangladesh's Blue economy with hydrographic data.

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Commander Md Yousuf Ali, (H1), psc, BN got commissioned in Bangladesh Navy on July 2007. Earlier, he has completed MSc in Physics from Jagannath University, Dhaka.

In his naval service he served on board various ships and establishment in different capacities. He has commanded BNS TALLASHI, BNS CHITRA and served as Executive officer, survey officer of BNS AGRADOOT (Ex). He has served as staff officer Operations to BN Chief Hydrographer, Deputy Chief Hydrographer and Staff Officer Hydrography at Naval Headquarters level. He was the Officer in Charge of Bangladesh Navy Hydrographic School. He did PSC from Defense Services Command and Staff College, Mirpur Dhaka along with Masters in Social Science and Security Studies from University of Professionals. He is Specialist on Hydrography and completed CAT A Hydrography course from National Institute of Hydrography, GOA, INDIA and achieved Post Graduate Diploma in Hydrography from GOA University, INDIA. He has also completed Oceanography Principle and Application Course from NOAMI, Dhaka. He has participated in UN Peacekeeping Mission in South Sudan. Presently he is serving as Deputy Director Hydrography at Naval Headquarters.

WAVE ENERGY : A PROMISING SOURCE OF RENEWABLE ENERGY AT COASTAL AREA

Lieutenant N M Saruar Jahan, (E), BN

Abstract

Ocean waves are a great source of unexploited energy resource. This unexploited energy can be used to produce renewable energy, specially at coastal areas where the kinetic energy of the ocean waves can be used. Nowadays the world is looking for an alternate solution of fossil fuel. Renewable energy is an option to decrease the use of fossil fuel based energy production. Ocean waves can be used to generate electricity by harnessing the kinetic energy of the waves at coastal area. There are various wave energy converter technologies which can be used to generate electricity by using ocean waves. These technologies include oscillating water columns, point absorbers and attenuators which has several advantages, limitations and challenges. It also has several environmental impacts regarding the extraction of wave energy. This paper provides an overview of wave energy and economic feasibility along with its environmental impacts of various wave energy extraction technologies.

Introduction

Renewable energy plays a vital role in addressing the urgent global challenges of climate change and environmental sustainability. Unlike fossil fuels which contribute significantly to greenhouse gas emissions and air pollution, renewable energy sources such as solar, wave, wind, hydro and geothermal power. These kinds of energy resources offer clean and inexhaustible alternatives. By harnessing these sources, we can reduce our dependence on finite fossil fuels, mitigate the impact of climate change and protect ecosystems. In fact, about 80% of the world's total use of energy is sourced from fossil fuels which is directly related with the environment pollution [4]. Moreover, the shift towards renewable energy promotes energy independence, stimulates economic growth through

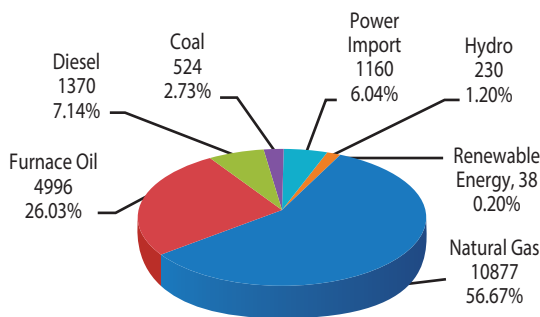
innovation in green technologies and enhances energy security by diversifying energy sources.

There are several sources of renewable energy where wave energy is one of the most sustainable renewable energy sources. Many countries are utilizing tidal energy to generate electricity in order to effective transition of the energy sector to sustainable energy. Bangladesh has also opportunity to develop the sources to harvest electricity from wave energy as this country has a coastal zone which covers an area of 47,201 km² or 32% of the country, being the landmass of 19 districts [5]. So, there is a huge opportunity to utilize this wave energy for generating electricity.

RENEWABLE ENERGY SCENARIO IN BANGLADESH

In our country, several renewable energy resources are used such as solar power, wind power and biomass in a limited range. But wave energy is a significant resource of renewable energy which is not utilized in our country. However, we are still lagging behind in the scientific and efficient use of such energy sources. Renewable energy is chosen for its environment friendly characteristics whereas our energy sources are fully depending on non-renewable fossil fuel.

Figure 1: Fuel Used for Electricity Generation [7]



At present, the generation of electricity in our country is fully dependent on non-renewable sources. Only 0.20% of electricity is generated from renewable sources [7]. A huge percentage of power production is dependent on natural gas

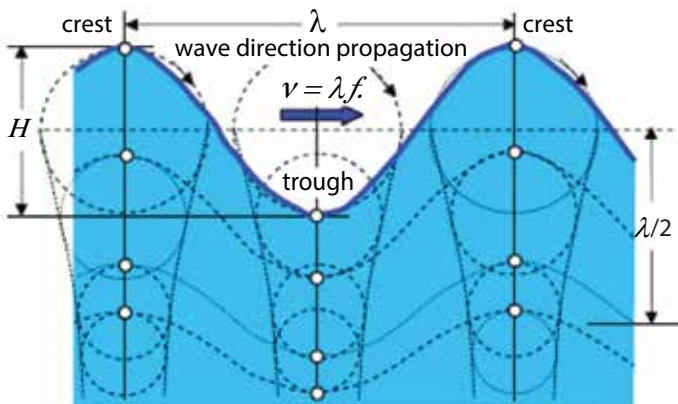
utilizing 56.67% of our gas reserve, which is 37% of total gas but consumption of gas is increasing at a rate of about 8% per year [6]. The other resources are 26.03% furnace oil, 7.14% diesel oil and 2.73% Coal [7]. Here, the percentage of renewable energy is very less and there is no utilization of wave energy.

WAVE ENERGY

Wave energy is a source of renewable energy which is directly generated from the tide of the ocean. It is a special type renewable energy which can produce electricity without any emission of harmful gas that pollutes air. As Bangladesh has a coastal area of 47,201 km², it can be a significant source of renewable energy for our country [5].

a. **Wave Formation :** A combination of forces due to gravity, marine tension and air intensity are key factors in the production of marine waves [3]. The wave formation and the wave length is totally depended upon the wind speed and depth of the water. Waves of sea have a regular shape at far distance which is called as swell. Wind-driven water particles show circular trajectories with the maximum radius on the surface and go on decreasing with depth [3]. This combination of circular movement is responsible for the wave formation and proper distribution, as shown in Fig 2. Wavelength can be determined by measuring the distance between two crests or two troughs. The height of the wave H (crest to trough) is proportional to the air intensity and its duration [3].

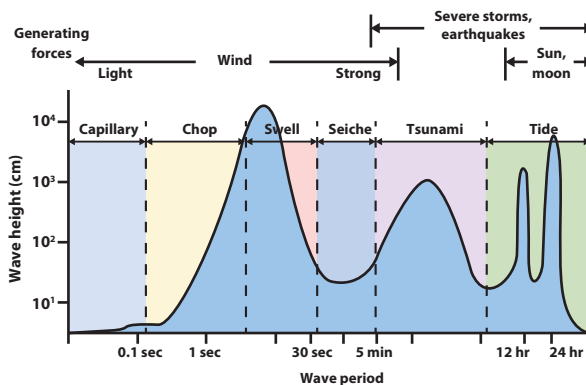
Figure 2 : Sea Wave propagation [2]



The frequency $f = 1/T$ specifies the number of waves to appear in unit time. As a result, the velocity of the wave will be $v = \lambda / t = \lambda / f$. The ratio $\lambda/2$ is called the wave declivity. Long-term waves have relatively long wavelengths and move fast. The large waves are strong which contain more energy [3].

b. Properties of Wave : Waves are created on the water surface which has adulatory motion. The properties of wave is specific and they don't depend upon their physical substance. The characteristics are common such as electromagnetic, mechanical etc [8].

Figure 3: Idealized Wave Spectrum [9]



There are two types of wave categories. They are Progressive wave and Standing wave. Progressive wave represents surface wave, internal wave, Tsunamis etc. Standing wave means swelling of water which has wave crest and wave trough. There are certain parameters of waves which are height (H), wave amplitude ($1/2 H$), wave length (L) and wave period (T) [9]. Waves can be categorized as capillary waves, chop, swell, or Tsunamis based on their wave duration. The majority of the waves on the ocean's surface are caused by wind. The initial condition of the sea surface, fetch, wind velocity and wind duration all affect the size and kind of waves produced by wind. Wave length, period and height of wave increase with the wind velocity. Wave energy and wave form move forward as the wave passes but the water does not. As the wave passes the water molecules transform the energy from one another. Diameter of orbit is proportional to the wave size and inversely proportional to the depth of water [9].

WAVE ENERGY CONVERTER

Wave Energy Converter (WEC) is a device which is designed to produce electricity by using ocean waves. Generally, the working principle is to convert the kinetic and potential energy of the waves into electrical energy. This can be achieved through various mechanisms such as oscillating water columns, point absorbers, attenuators and each of these is designed to interact with waves in different ways. Some Wave Energy Converters have hydraulic systems that use electromagnetic generators or pneumatic systems to convert mechanical motion into electrical power.

a. **Classification of WEC :** There are several classifications of Wave Energy Converter. These classifications are based on their location, working principle and so on. Some of these are described below :

(1) **Shoreline Devices :** These kinds of devices are installed on the coast. The advantage of these kinds of devices are about their installation and maintenance. Shoreline devices are easy to install and maintain. The implementation of this devices are limited to shoreline and totally depends on tidal range [3]. Some examples are Oscillating Water Column, Limpet etc.

(2) **Near Shore Devices :** These devices are installed within 1 km of the shore. The maximum depth is limited up to 20m from the shoreline [3]. Electric Cables are used to transfer the generated electricity to the grid. Some examples are Oscillating Water Surge, Osprey etc.

(3) **Off Shore Devices :** These devices are installed at a depth of above 40m and face more powerful waves than near shore device. Off Shore Devices are mainly three categories based on their operations [3]. These are floating device, partially submerged device and fully submerged device.

b. **Types of Wave Energy Converter (WEC) :**

(1) **Pelamis Wave Power :** The Pelamis is an attenuator type of Wave

Energy Converter which has axis towards the wave direction. There are several segments that oscillates due to wave motions. While the segments moves then the oscillatory motion of the waves pumps oil to the hydraulic system while converts the motion into energy.

Figure 4 : Pelamis Wave Power [16]



(2) **Point Absorber** : This is a floating structure which moves up and down with the wave. This movement converts the wave energy into electric power which is carried out through a direct drive generator that continuously charges an on-board battery pack (Energy Storage System). The structure is small in size and it totally depends on the swelling of the wave rather than the size of the wave.

Figure 5 : Point Absorber (Power Buoy) [11]

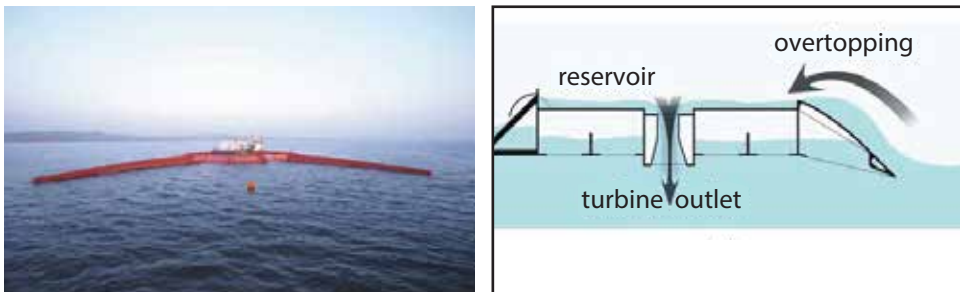


(3) **Wave Dragon** : Wave Dragon is a floating offshore structure which is designed to capture wave energy through a unique floating platform.

Wave Energy : a Promising...

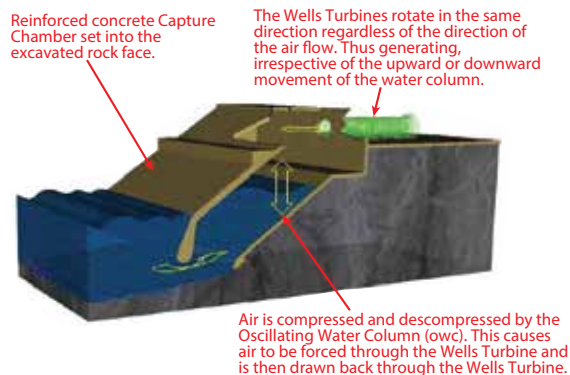
The platform consists of two arms that capture and funnel waves into a reservoir. As waves enter the reservoir, they cause water levels to rise and fall by creating an oscillating water column effect. This movement drives air in and out of turbines located at the top of the reservoir and generate electricity.

Figure 6 : Wave Dragon [1]



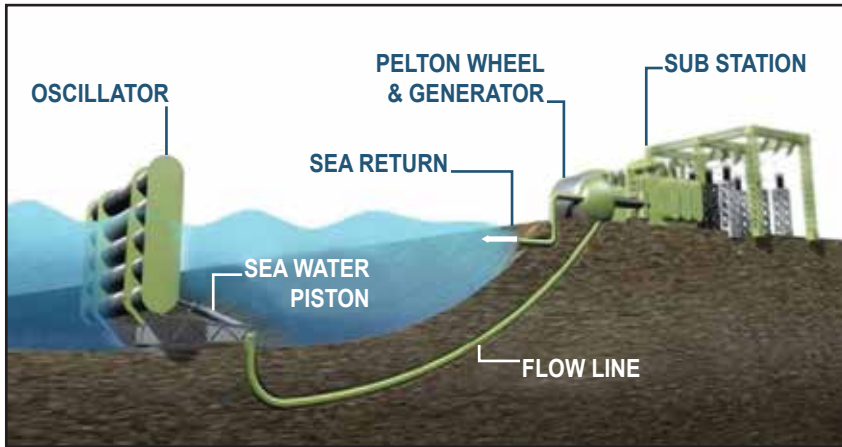
(4) **Oscillating Water Column** : This device consists of a partially submerged chamber which has an opening to the sea below the waterline. As the wave approaches, the water is forced into the chamber and apply pressure on the air within the chamber. The air release to the atmosphere through a turbine. When the water fall down, the air is also drawn to the chamber through the turbine. This back and forth movement of air generates mechanical energy through turbine and then converted into electricity.

Figure 7 : Oscillating Water Column [3]



(5) **Oscillating Water Surge Converter** : This is a nearshore device where the top of the deflector is above the water surface and is hinged from the sea bed. As waves pass through the device, it causes the structure to oscillate vertically and horizontally. The motion of waves pushes and pulls on the

Figure 8 : Oscillating Water Surge Converter [3]



structure, causing hydraulic fluids or other mediums to move through a hydraulic system. This movement drives a hydraulic motor or generator which convert mechanical energy into electricity.

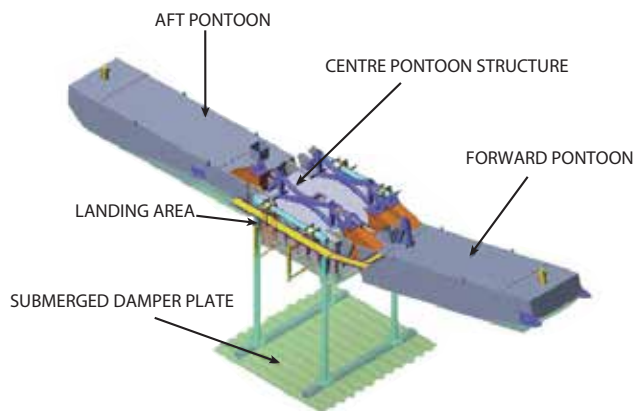
(6) **Submerged Pressure Differential** : This device uses pressure differential on the top which is a point absorber. It utilizes the difference of pressure between wave crests and troughs. It has mainly two parts: A sea bed portion and an air fill chamber which is submerged in the water [1]. When a wave passes through the crest, the cylinder moves down due to the pressure on the top of the device. The cylinder moves upward due to the release of pressure as the troughs pass through the device. This translatory motion is used to convert electricity by using a linear generator. As the device is fully submerged, it is not exposed to the dangerous slamming forces experienced by floating devices [12].

Figure 9 : Submerged Pressure Differential [1]



(7) **The McCabe Wave Pump** : This device consists of three pontoons which are hinged with one another. These are pointed with the direction of wave. The center pontoon is attached with a damper to remain stationary. The other two pontoons move with the movement of the wave. This oscillation causes the movement of hydraulic fluid and this pressurized hydraulic fluid can be used to drive a motor generator (rated at 200-500KW) [13].

Figure 10 : McCabe Wave Pump [13]



BENEFITS AND ENVIRONMENTAL IMPACTS

Wave energy is a promising renewable energy source that harnesses the kinetic energy present in ocean waves to generate electricity. This form of energy extraction is still in the early stages of development but shows significant potential due to its predictable nature and high energy density. Wave energy represents a promising source of clean, renewable energy generation with numerous environmental, economic and social benefits. It has several impacts on the environment also. The benefits are projected below :

a. **Alternate Energy Resource** : Wave Energy can be an alternate source of energy generation as renewable energy. Unlike fossil fuels, wave energy is abundant and predictable, offering a sustainable solution to meet global energy demands while reducing greenhouse gas emissions. The power generation using wave energy is not as large as conventional sources of power generation but it represents a cleaner and alternative energy source.

b. **Low Greenhouse Gas Emissions** : Wave energy generation represents a promising source towards sustainable power production, characterized by its minimal greenhouse gas emissions and environmental impact. Fossil Fuel based energy sources such as coal or natural gas release significant amount of Carbon di Oxide and other harmful pollutants to the atmosphere during combustion. On the other hand, wave energy utilizes the kinetic energy from the waves without burning any fuel. Thus, wave energy is a possible source of energy by mitigating air pollutions and greenhouse gas emissions associated with electricity generation. By harnessing the power of waves, a greener and more sustainable energy production system can be made with less greenhouse gas emission.

c. **Reliable Source of Energy** : Wave energy is a reliable source of energy due to the consistent and predictable nature of ocean waves. Unlike some other renewable energy sources like wind or solar, which can be intermittent depending on weather conditions. Waves are more stable and predictable than

other renewable resources. This predictability allows for better planning and integration into the energy grid, providing a steady supply of electricity. Additionally, waves are abundant and widespread across the world's oceans, offering a vast potential resource for power generation.

d. High Power Extraction Ratio : The power extraction ratio of wave energy is comparatively higher than other renewable energy sources. In case of other renewable resources where the energy production is totally depends on the weather. Wave energy is less dependent on weather. Electricity power extraction from wave energy is continuous which is 90 percent of the day. But the ratio is 20 percent and 30 percent for wind and solar energy [14].

e. Effects on Marine Ecology : The disturbance and noise during installation and operation of devices will affect marine species for their life. Marine birds, marine mammals, benthic ecology, fishes and other species are a part of our ecology system. The disturbance and noise during installation and operation of devices will affect marine species for their life. Also, there is a risk of collision with devices during forging, feeding and migrating. This wave devices probably will make water contaminated, which will have negative influence on marine species [14]. Some effects on Marine Ecology systems are described below:

(1) Physical Disruption of Marine Habitats : The installation of WECs typically requires modifications to the seafloor, such as dredging or the placement of anchors and moorings. These activities can disrupt benthic habitats and affect organisms living on or near the seafloor. Wave Energy Converters can influence local sediment dynamics. By altering wave patterns and currents, these devices may change sediment deposition and erosion patterns, potentially affecting coral reefs, seagrass beds, and other critical habitats.

(2) Impact on Marine Species : The presence of Wave Energy Converters can lead to changes in the behavior of marine species. For instance, marine

mammals and fish may alter their feeding or migration patterns to avoid areas with high energy converter activity. These Converters generate underwater noise during their operation and maintenance. This noise can interfere with the communication and echolocation of marine mammals such as whales and dolphins, potentially leading to stress or disorientation.

(3) Ecological Interactions : The presence of these converters can create new structures on the seafloor which may act as artificial reefs. These new structures could provide habitat for certain species while displacing others and thus changing the local biodiversity.

f. Hydrodynamic Effects : The extraction of energy from waves can affect the local hydrodynamics, potentially leading to changes in wave heights and currents. These changes can impact coastal processes and the distribution of marine organisms. Long term impacts on wave patterns could influence sediment transport along the coast which may affect shoreline stability and the health of coastal ecosystems.

g. Chemical and Environmental Pollution : While these converters offer a promising alternative to fossil fuels and have the potential to reduce greenhouse gas emissions, they can also introduce new challenges related to chemical and physical pollution. Here is a comprehensive look at how these converters might impact marine environments in terms of both chemical and physical pollution :

(1) Hydraulic Fluids and Chemical Lubricants : Many Wave Energy Converters use hydraulic systems to transfer mechanical energy from wave energy. These systems often rely on hydraulic fluids and lubricants that could potentially leak into the marine environment. The movement of different hydraulic converter needs grease or supply of continuous lubricant. If these chemicals escape, they could harm marine life by contaminating the water.

(2) Corrosion and Anti-Fouling Agents : The harsh marine environment can lead to the corrosion of metal parts in wave energy converters. To resist

this corrosion, some anti-corrosion coatings and anti-fouling agents are often used. These substances can sometimes leach into the ocean, potentially affecting water quality and marine ecological environment.

(3) Noise Pollution : The operation of Wave Energy Converters can generate underwater noise which might disturb marine species, especially those that rely on echolocation or sensitive acoustic environments, such as whales and dolphins.

h. Navigation Hazards : The placement of Wave Energy Converters in the ocean could pose a risk to marine navigation, especially if they are not well-marked or if their locations change over time. This could potentially lead to accidents or collisions with boats and ships. Some converters have submerged or partially submerged components like anchor cables, mooring lines or underwater turbines that could increase the risks.

j. Eco-Tourism Opportunities : The presence of wave energy converters can boost the development of eco-tourism. These projects of power development requires large infrastructure development throughout the coastal area. Eco Tourism opportunities can be created to attract tourist and other visitors. It can be also used to provide educational opportunities by creating different technical institutes to build skilled manpower associated with power sector. Additionally, eco-tourism can create new revenue streams and job opportunities for local communities.

PROSPECTS OF WAVE ENERGY IN BANGLADESH

Wave energy is a non-depleting source of emission free power source. The overall cost of Wave Energy Converter is its installation and maintenance cost because the waves are free and the source will not run out. It has less environmental impacts and risk factors compared to other conventional power generation system. Bangladesh has also opportunities for power generation using wave energy for its geographical location.

a. **Area Selection** : Bangladesh's large and long coastal area can be used for electricity generation to minimize the energy crisis. The scope of power production can be assessed by observing wave power and height. Most of the recent research indicates that the wave height produces in the coastal regions of the Bay of Bengal lies between (0.5-3.5) m, which is very much suitable for wave power [19]. Three stations can be considered according to the wave heights and other characteristics which are described below [20] :

- (1) **Station-one:** Basin of Possur River of Khulna
- (2) **Station-two:** Basin of Karnaphuli River
- (3) **Station-three:** Bay of Bengal (Cox's Bazar & Saint Martin)

Figure 11 : Possible Sites for Wave Energy Extraction



The possibilities of power production per square meter area varies with different times throughout the year. By a research, it was observed that in all stations, the maximum power output can be achieved at July, August and September month [20]. The power output is maximum for its highest average wave height at this period. The power production is continuously increasing and decreasing with the variation of tides. For every six hours it is maximum and then goes to a minimum [20]. The maximum and minimum power productions are directly related to the rising and falling of tides.

b. Suitable Wave Energy Converters for Bangladesh : Wave energy is a potential energy resource for electrification. Bangladesh has also possible scopes to build different power plant based on wave energy. Wave height in the Bay of Bengal is of maximum 2.9m from recorded data and approximate average wave height is 2.6m [18]. The wave period is about 8 to 9 sec. By energy calculation the average power output can be get 27kw from a single unit. There are several converters can be installed to produce electricity from wave energy. A research has shown that Oscillating Water Column and Pelamis might be a suitable option to gain maximum output in our selected area [18].

Oscillating Water column can be installed as onshore plant. This converter has some specific characteristics upon which it can be considered for these geographical location. The characteristics are given below [18] :

- (1) This converter uses Wells Turbine whose direction of rotation remains same with the direction of water.
- (2) Produce high air pressure.
- (3) Simple Construction.
- (4) Less Maintenance is required.

Pelamis can be installed as offshore plant. It can be installed for some specific characteristics regarding the direction of wave. The characteristics are given below [18]:

- (1) Pelamis has cylindrical tube section which does not depend on the direction of wave.
- (2) Less installation cost required.
- (3) Similar power output compared to modern wind turbine.
- (4) Long Survivability.

Conclusion

Wave Energy can be considered as a potential source of generating electricity. Nowadays the demand of electricity generation increasing and the storage of fossil fuel is decreasing continuously. In this scenario, wave energy can be a possible clean energy technology as ocean is a huge resource for harnessing energy. Wave energy is not expensive to operate and maintain, no fuel is needed and no waste is produced. There are several types of Wave Energy Converters are available through which the kinetics energy of the ocean waves can be converted into electrical energy. Different kinds of converters can be installed at different geographical locations according to its operating procedure. These kind of converters have some impacts on environment such as some pollution and ecological imbalance might be occurred for its operation. But as a renewable energy resource it is safer than other conventional energy production system. The power generation using wave energy is not as large as conventional sources but it represents a cleaner and alternative energy source. Bangladesh has also many scopes to harness wave energy for energy production for its geographical location. It can be a viable and promising source for addressing Bangladesh's growing energy needs while contributing to sustainable development maintaining a cleaner and greener environment.

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Notes and References :

1. P.K. Hitti, Islam A Way of Life, London, Oxford University Press, 1970, p. 90
2. Salar Khan et al, Scientific Indications in the Quran, Dhaka, Islamic Foundation of Bangladesh, 1995, pp.33-35
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6. Forces Goal 2030 is a long term modernization program for Bangladesh Armed Forces. Its main purpose is expanding the force size, acquiring modern war weapons and equipments and providing advanced level training. The Goal also stresses on developing indigenous defence industries.

B. Journal/Magazine/Periodical Referencing :

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