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MESSAGE FROM THE CHIEF OF NAVAL STAFF

'Bismillahir Rahmanir Rahim'

The 9th edition of the 'Navy Journal 2024' is heralded with immaculate thoughts and ideas of inquisitive writers, dedicated to appraising maritime domain issues. This Journal stands as a testament to our commitment to excellence, offering a forum to share our expertise, insights and foster mutual learning. Its purpose is to disseminate knowledge to those who are striving to improve the quality of their studies. As such, it remains as an important function of this Journal.

Emerging from the glorious war of liberation, Bangladesh Navy has already entered into the era of three-dimensional Navy. I express my humble respect and deep gratitude to the greatest Bengali of all times, Father of the Nation Bangabandhu Sheikh Mujibur Rahman, whose pivotal role orchestrated the development of Bangladesh Navy. His contributions laid the foundations for a strong naval force essential for safeguarding the sovereignty and security of the independent nation. Bangabandhu Sheikh Mujibur Rahman's visionary leadership and strategic initiatives were crucial in the establishment and initial growth of the Navy. His efforts laid the foundation for a capable maritime force that continues to play a vital role in safeguarding Bangladesh's maritime interests and ensuring national interest at sea.

Continuing this legacy, Honorable Prime Minister Sheikh Hasina has guided us towards the development and modernization of Bangladesh Navy. Her commitment to enhance country's naval capabilities and strategic vision in strengthening the Navy has been unprecedented. It has allowed us to transform into a more capable and technologically advanced maritime force, to protect our maritime domain. Now, it is our responsibility to make our navy a 'Smart Navy' by the year 2041 in keeping with the vision of 'Smart Bangladesh'.

I express my sincere gratitude to the members of the editorial board and all concerned in the editorial office for their collective effort and dedication to this Journal. I also thank all the submitting authors who have toiled in the production of their work and have made 'Navy Journal 2024' their Journal of choice. Together, let's embrace this platform as a means to propel our organization to new heights of achievement.

May Almighty Allah SWT endow us with His kind blessings.

Joy Bangla.

M NAZMUL HASSAN
Admiral
Chief of Naval Staff

EDITORIAL

Since its inception, Navy Journal has served as a repository of knowledge and expertise within the naval profession and beyond. It showcases outstanding contributions from talented naval officers, who, amidst their busy schedules, share their specialized knowledge and professional experiences through articles that blend empirical research with philosophical insights. These officers demonstrate a commitment to innovation, enriching the journal with diverse ideas and perspectives.

This journal promises to enhance readers' understanding of cutting-edge developments in maritime affairs. The editorial board has meticulously studied articles across various subjects to ensure a high-quality publication that captivates readers' interests. Through its multidimensional content, the journal aims to satisfy readers' thirst for knowledge, presenting empirical ideas with fluency and modern linguistic flair.

We extend our heartfelt gratitude to the Chief of Naval Staff and the Chief Patron for their invaluable guidance and support. Additionally, we appreciate the cooperation and efforts of all involved in facilitating the timely publication of the "Navy Journal 2024."

May we be blessed with the mercy and guidance of Allah SWT as we endeavor to serve our nation with unwavering dedication and honor.

MARITIME SECURITY COOPERATION IN SOUTH ASIA - CHALLENGES AND PROSPECT

Rear Admiral Mohammad Anwar Hossain, NGP, PCGM, BCGMS, ndc, afwc, psc

Abstract

The sea, historically crucial for commerce and resources, has gained even greater importance with globalization, leading to increased connectivity. Littoral states benefit from authorized jurisdiction areas under the United Nations Convention on the Law of the Sea (UNCLOS III). The strategic importance of the sea, their vast resources, and the interconnectedness of global trade, also derives challenges posed by illegal activities like piracy, poaching, and unlawful uses. The challenges to Maritime Security Cooperation (MSC) in South Asia (SA) are multifaceted. The rise in defense spending and arms race among SA countries, internal conflicts in inter-state disputes, and trans-boundary issues pose hurdles. This writing underscores the potential challenges due to conflicts in the Bay of Bengal region, including geostrategic tensions and the growing energy demand of emerging powers. Non-traditional threats, such as piracy, maritime terrorism, and illegal fishing, further complicate maritime security. The paper highlights the need for regional cooperation and addresses the potential for conflict resolution through international mechanisms. Despite challenges, the prospects for enhanced maritime cooperation in SA are evident, with resolved maritime boundaries, international cooperation agreements, and ongoing collaborative projects.

Introduction

Maritime security cooperation (MSC), including naval cooperation, whether at the bilateral or multilateral levels, within alliances, coalitions or in a non-coalition environment, as part of an ongoing security relationship or simply on an ad hoc basis, has flourished (Rahman, 2009). Connectivity through the sea increased phenomenally with globalization. Littoral states benefit from their sea

due to authorized areas of jurisdiction by the United Nations Convention on the Law of the Sea (UNCLOS III). The strategic importance of the seas due to its vast resources and interconnectivity also brings ahead the importance of security to the resources as well as to the lawful uses of the seas. To ensure security at sea, maritime security cooperation (MSC) among the littorals got importance. Due to the nature of the sea and its use around the world, it is not practicable to ensure security by a single state even if it is powerful. Littoral states around the world made tremendous efforts for MSC mainly in terms of regional, sub-regional and also bilateral cooperation. The abundant resources therein and in the sub-soil of seas along with ever increasing global trade through seas and the economic value and volume, attract a lot of illegalities like piracy, poaching and illegal and unlawful uses which constitute maritime security threats to the littorals. Consequently, ensuring maritime security against a wide spectrum of threats has become necessary for nations (Bessing 2016).

Given the benign nature of peacetime maritime cooperation activities, the littoral states are more than willing to cooperate with each other to mutually augment their maritime capacities. (Upadhyaya 2018). The geophysical attributes of the sea areas of South Asia (SA) coupled with a high volume of maritime trade have implications for regional security. There are challenges which also open new areas of opportunity. Challenges are common and are also potential change multipliers which could throw up complex challenges in the future, far beyond the capacity of any single littoral state to tackle. Due to the complexities of maritime environment and threats, no single state can counter these threats alone and littoral states need to cooperate in enhancing maritime security at regional, sub-regional and bilateral level. SA littoral states maintain bilateral and trilateral maritime cooperation like India, Sri Lanka and the Maldives have a trilateral cooperation ‘Dosti’. Bangladesh and India conduct CORPAT along the IMBL which facilitates to prevent unlawful activities. However, SA littorals are yet to form an institutionalized regional MSC platform to address the maritime security issues regionally.

In this backdrop, this paper seeks to study the challenges of Maritime Security Cooperation among the SA states with a view to find opportunities in enhancing MSC in SA.

South Asia and Maritime Environment

South Asia region consists of the countries of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. Topographically, it is dominated by the Indian Plate and defined largely by the Indian Ocean on the south, and the Himalayas, Karakoram, and Pamir mountains on the north. South Asia is bounded by Western Asia, Central Asia, East Asia, and Southeast Asia (Bank, South Asia, 2022). South Asia covers about 5.2 million km² (2.0 million sq mi), which is 11.71% of the Asian continent or 3.5% of the world's land surface area. The population of South Asia is about 1.94 billion (2020) or about one-fourth of the world's population, making it both the most populous and the most densely populated geographical region in the world. Overall, it accounts for about 39.49% of Asia's population, over 24% of the world's population, and is home to a vast array of people (Bank, South Asia, 2022). Maritime SA is surrounded by three water bodies, the Bay of Bengal, the Indian Ocean and the Arabian Sea and has acutely varied climate zones. Afghanistan, Bhutan and Nepal are the three landlocked countries of SA without sea territories.

UN Cartographic Map of South Asia



Challenges of Maritime Security Cooperation in SA

Defence Spending and Arms Race

Defence spending has increased and there is a growing arms race in SA states. According to estimates by the Stockholm International Peace Research Institute (SIPRI), defense spending by the SA countries has roughly doubled in the past decade (2000–2010) (SIPRI, 2022).

Table : 1 Defence Spending in SA

Economy/Year	2010 (US$ billion)	2021 (US$ billion)
India	46.09	76.6
Pakistan	5.97	11.3
Bangladesh	1.62	4.9
Afghanistan	0.30	0.3
Sri Lanka	1.53	1.6
Nepal	0.25	0.4

(Sources : SIPRI 2022)

Above data is an indication of growing defense spending in SA and likely to continue in future. Historically, defense spending and arms imports in South Asia have been determined by a variety of factors like disputes and tensions among the countries and their neighbors, domestic insurgencies, concern for the security and safety of sea lanes from disruption by piracy and terrorism (which are common security concerns), extra-regional security challenges etc. However, the defense spending and arms purchases did not destabilize intra South Asian relations. This is a hopeful sign which indicates that SA littorals will not put guns before butter.

Internal Conflicts, Inter-States Disputes, Trans Boundary Issues

Presently, Myanmar is facing serious intra state insurgency challenges. Military rule, which accounted for some of the worst human rights violations in the region is continuing in Myanmar. Domestic conflicts of Myanmar not only challenge its internal stabilities, but also stability of its neighbors and the region as a whole. Many domestic conflicts tend to spill over national boundaries, especially when militants or refugees flee the conflict zone and seek asylum in neighboring states. As the SA states are closely connected through the sea territory, domestic conflicts affect the MSC of SA. Inter-state conflicts have posed hurdles to regionalism. This phenomenon is clearly visible in the functioning of the South Asian Association for Regional Cooperation (SAARC) (Bhatgagar, 2018). The table below shows the interstate disputes and conflicts among the SA states :

Table 2. Types of Conflict and Disputes Between the States of SA

Type of Conflicts and Disputes	Countries Involved	Conflict and Disputes
Territorial Conflicts	India-Pakistan	Deadlock on issues of Siachen, Glacier, Kargil, Sir Creak Kashmir disputes caused two major wars
	Afghanistan-Pakistan	Durand line issues
Cross-border Terrorism	India-Pakistan	Terrorist activities in both countries blamed from both sides
Natural Resources	India-Pakistan	Building Dam on river Baglihar
	India-Bangladesh	Water sharing from major rivers coming from India to Bangladesh
Immigrant, Refuge and Forcefully Displaced Myanmar Nationals (FDMN)	Afghanistan-Pakistan	Cross Border Military
	Nepal-Bhutan	Over repatriation of Bhutanese refugees in Nepal
	Bangladesh-Myanmar	Forcefully Displaced Myanmar Nationals (FDMN) movement across the border

(Prepared by author taking information from available sources)

The prevalence of several inter-state conflicts in SA is not because the stakeholders in conflicts are not highly motivated towards a productive peace-building process; involving bilateral dialogues, third-party mediations, back channels, track II diplomacy, etc (Ahmad, 2015). The involvement of SA states in peace-building initiatives is evident in its long-term participation in the UN Peacekeeping Operations. Four of the world's top UN peacekeepers are from South Asia; Bangladesh, Nepal, Pakistan and India (UNDPKO, 2020). It is ironic, therefore, that the same global peacekeepers continue to put deadlocks in several conflict resolution processes within their own region.

Due to geographical reality, maritime security challenges to SA littoral states are directly linked to the maritime security challenges of Bay of Bengal (BoB).

The BoB region is vital to Asia's rising powers, but its low-lying littorals are vulnerable to a number of trans-boundary issues and threats. Manmade and some natural challenges to maritime security include climate change, IUU fishing, marine pollution, increase of salinity in the coastal belt, degradation of critical habitats, etc. The BoB's coasts are threatened by water conflicts in the Himalayas, and by the fracking of oil and gas in the deep sea. Dam construction in China and India poses a threat to downstream communities in India, Bangladesh and mainland Southeast Asia (Ahmad, 2015)**.** The rising sea level, the subsiding of deltaic lands, and the accelerated intrusion of saltwater onto farmlands pose a severe threat to food production that would adversely affect millions. Climate change has exacerbated these impending consequences. Besides, a rise in the frequency and intensity of the Bay's deadly cyclones affecting millions of people in Bangladesh, India, Myanmar and Thailand.

Maritime challenge to littorals of SA is also linked to the stability of the states' due to limited institutional capacities of the littoral nations. Recent economic crisis of Sri Lanka and political instability coupled with insurgent movements against the military Govt of Myanmar are causes of concern. Internal political instability is considered to be one of the main obstacles to development, growth and cooperation. The SA littoral states urgently need more effective cooperation for environmental protection and the mitigation of terrorist and piracy attacks on crucial sea routes.

There are certain potential sources of conflict in the BoB geostrategic tension, growing energy demand leading to greater competition, and maritime relations, to name a few. The rise of China and India is affecting the international geopolitical landscape. As world history attests, the dramatic rise of a new power usually creates volatility in the international system(Ahmad, 2015) . The growing energy demand of the emerging powers will likely become a source of contention and competition. Additionally, since most of the major players in the Bay are investing in a military build-up, the nature of the confrontation might become more problematic. It is difficult to predict if and how these disputes will heat up but they are all potential sources of conflict and rivalry (HCSS, 2010).

Non-traditional Threats to Maritime Security in SEA and SA

Piracy

Piracy is a form of barratry which has become the bane of the modern seafarer (Ghosh, 2005). Piracy is a concern for SA in the realm of Bay of Bengal (Alam M. K., 1997). The littorals of South Asia need for maritime cooperation particularly to vie against the threats entwining narcotic terrorism, sea piracy, marine environment protection, checking smuggling and illegal fishing (Alam M. K., 1997). Each South Asian state has its respective self-images as well as perception of strength, weakness and vulnerability (Kalam, 1998). South Asian states now require a model of common and comprehensive security that would help reduce their mutual vulnerabilities.

Towards the end of the twentieth century, after a period of generally peaceful global maritime trade that lasted well over a century, piracy or armed attacks on ships as classified by the International Maritime Organization (IMO) first re-emerged in the Strait of Malacca; manifestly precipitated by the financial crisis in the region(Raymond, 2009).

In 2022, Regional Cooperation Agreement on Combating Piracy and Armed Robbery Against Ships at Sea (ReCAAP) recorded three incidents of piracy in Chattogram port which were under Category-4 (Cat-4), which is defined as: “The perpetrators were not armed and the crew not harmed. More than half of CAT 4 incidents involved 1-3 men who escaped empty-handed upon being sighted by the crew(ReCAAP, 2021).The decrease of incidents in 2021 occurred in most locations in Asia; namely Bangladesh, India, Indonesia, Malaysia, the Philippines, Vietnam, South China Sea and the Sulu Celebes Seas. However, there was an increase of incidents in the Singapore Strait in 2021.

The decrease of piracy incidents in 2021 as compared to 2020 occurred in SA and SEA is shown in the following table (ReCAAP, 2021) :

Table. 3 Piracy Incidents in 2021 as compared to 2020 occurred in SA and South East Asia

Country	Year 2020	Year 2021
Bangladesh	05 (Cat-4)	Nil
India	09	05
Indonesia	22	13
Malaysia	03	01
Philippines	13	11
Vietnam	06	02
South China Sea	04	Nil
Sulu-Celebes Sea	01	Nil

Maritime Terrorism

In addition to piracy, terrorist attacks took place in the beginning of the twenty-first century including the attacks on USS Cole and the French Tanker Limburg in the Gulf of Aden in 2000 and 2002, respectively. By 2007, Admiral Sureesh Mehta the former Indian Naval Chief opined that "the Indian Ocean had become the de facto home of global terrorism, with many regional states covertly or even inadvertently aiding and abetting subversive elements"(Times, 2007). The most daring terrorist attacks conducted in the region were the 26 November 2008 attacks in Mumbai in which ten armed terrorists infiltrated through the west coast of India, killing over 160 people including several foreigners, and women and children. Subsequent terrorist attacks in the region include a brazen attack by a terrorist outfit known as Al Qa'ida in the Indian Subcontinent (AQIS, an affiliate of the Al Qa'ida) which successfully penetrated into a Pakistani naval dockyard in an attempt to seize the frigate, PNS Zulfiqar, in September 2014(Panda, 2014). These incidents clearly indicate that the threat of maritime terrorism is prevalent in the region and these terrorist groups may find the maritime sector a weak and vulnerable target. It is therefore opined that maritime security in the region will continue to remain fragile and require unhindered and sustained regional maritime cooperation to maintain good order and stability at sea.

Illegal, Unreported and Unregulated (IUU) Fishing

Relative to piracy and terrorism, IUU fishing also poses Non-Traditional Security (NTS) threats in the region. Although IUU fishing is an issue of global concern it is widely prevalent in the BoB which is adversely impacting the sustainability of fish stocks in the SA region. According to the Food and Agriculture Organization (FAO) of the United Nations, about 50 percent of marine fish stocks are fully exploited, 15 to 18 percent are over exploited, and ten percent are already depleted (Sahuja, 2016). Illegal fishing also led to depleted fish stocks and local fishermen find ways for survival and chose piracy. Rise in IUU fishing is threatening regional maritime security and undermining local economic development. Thus a comprehensive approach to maritime security in the region demands far greater focus on IUU fishing than is currently accorded. The Bay of Bengal is a hot spot for IUU fishing. There are vessels operating under flags of convenience, stateless vessels using falsified registry documentation, vessels obscuring markings, having no vessel markings or failing to have vessel documentation(Bergin, 2021).

Prospects of Maritime Security Cooperation in SA

Though there are challenges in the maritime arena due to diversified maritime threat and complexities, there are also prospects leading to maritime cooperation among the littorals of SA. Maritime boundary between Bangladesh and Myanmar remained unresolved for more than 40 years causing severe obstacle to exploration and exploitation of natural resources from sea for both the countries (Alam M. K., 2021). Finally, on 12 March 2012 through the judgement of the International Tribunal for Law of the Sea (ITLOS), the maritime boundary between Bangladesh and Myanmar was delimited. Similarly, through the judgment of the Arbitral Tribunal in the Permanent Court of Arbitration (PCA), Hague the maritime boundary between Bangladesh and India was also delimited on 07 July 2014. The above steps through international mechanisms have enhanced the intra-state relations between SA states. Various cooperation agreements made from time to time have established cooperative regimes and made the operationalizing of future endeavors much easier. Regular cooperation

improves the information available to member states, builds familiarity, lowers transaction costs, reduces distrust, and creates habits of consultation. Therefore, it starts the prospect of maritime confidence and security building that would enable the rapid development of maritime cooperation in SA in the near future.

There is no separate MSC forum or platform existing presently among the SA states. However, SA littoral states are maintaining maritime engagements in regional and sub-regional level. The Indian Ocean Rim Association (IOPRA) is a regional forum consisting of 23 member states bordering the Indian Ocean, ten dialogue partners and one Observer. IORA is tripartite in nature, bringing together representatives of Government, Business and Academia, to promote co-operation and closer interaction among them. The IONS is a series of biennial meetings between the navies of littoral states of the Indian Ocean region. It provides a forum to increase maritime security cooperation, discuss regional maritime issues, and promote friendly relationships among the member states. The diversified maritime security challenges in the SA region require regional cooperation and the littoral countries of SA need to cooperate and work together.

Conclusion

It is understood that maritime states have more incentive to cooperate than to confront each other in the maritime affairs especially in the field of economy and security. Over the last two decades, China and India have become increasingly economically interdependent. Regional and extra regional involvement in the development of SA littorals leads to even greater interdependencies. These economic interests reduce the risks of conflict, forcing the countries to think more about their mutual benefits. Bilateral and multilateral trade agreements and the expanding memberships of regional organizations such as SAARC, the Indian Ocean Rim Association (IORA), or the BIMSTEC have a positive effect. These institutions facilitate regional integration, mediate conflicts and promote healthy competition (Ahmad, 2015).

The ways in which the key powers will address mutual (and sometimes conflicting) maritime interests will directly effect the global balance of power and play a large role in determining the geopolitical landscape of the decades to

come. The most significant ones involve changes in the balance of power and the risk of violent conflict and insecurity along the SLOCs, resulting in large-scale economic disruption and the rerouting of energy supply (HCSS, 2010). Healthy maritime relations between the littorals of SA will contribute to address the maritime challenges in the SA region. In the greater perspective, MSC will also benefit extra-region due to the universal nature of oceans and seas as a great highway.

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Biography of the Writer



Rear Admiral Mohammad Anwar Hossain, NGP, PCGM, BCGMS, ndc, afwc, psc was commissioned in the Executive Branch of Bangladesh Navy on 1st January 1988 and has 35 years of outstanding blend of professional and academic career profile. He is a Navigation specialist and qualified Basic Navigation Course from Australia and Navigation and Direction Course from Pakistan. He commanded different types of warships of Bangladesh Navy ranging from Patrol Craft to Guided Missile Frigate. He has in his credit M Phil Degree in Security and Development and has also two Master's Degrees one in Security Studies and another in Defence Studies. Rear Admiral Anwar completed Naval Staff Course from Defence Services Command & Staff College, Bangladesh. He is also a graduate of Armed Forces War Course and National Defence Course from National Defence College (NDC) Bangladesh. The Admiral has successfully qualified in Combined Force Maritime Component Commander Course from USA. He served in UN Peace Keeping Mission as Staff Officer of Bde HQ at DR Congo. He also served in UN Maritime Task Force in Lebanon as Commander Task Group and Commanding Officer of Guided Missile Frigate BNS ALI HAIDER. He served as Director of Naval Plans and Director of Naval Aviation at Naval Headquarters. The officer also served in Bangladesh Coast Guard as Deputy Director General, Director Operations and Zonal Commander at different times. He was awarded with Navy Glorious Service Medal (NGP) as recognition of his glorious service and contribution to Bangladesh Navy and President Coast Guard Medal (PCGM) and Bangladesh Coast Guard Medal Seba (BCGMS) as recognition of his excellent performance in Bangladesh Coast Guard. Rear Admiral Anwar has commanded BN Special Force SWADS. He also served as Area Commander of Dhaka Naval Area, Khulna Naval Area and Assistant Chief of Naval Staff (Personnel). The Admiral is currently appointed as Assistant Chief of Naval Staff (Operations) in Naval Headquarters.

He is happily married to Lubna Anwar and blessed with one son and one daughter. His son is also a second generation navy officer. He is a keen Golfer and loves to read books and listen to music.

AN OVERVIEW OF EMI / EMC AND WAYS OF ITS MITIGATION ON MARINE PLATFORMS

Rear Admiral Khandakar Akhter Hossain, NUP, ndc, psc, PhD
Commander Sajia Sultana, (L), psc, BN
Lt Commander Mossammat Fatema Akter Royida, (L), BN

Abstract

Electronics has hugely shaped the development of modern technology. Starting from domestic appliances to warfare, electrical and electronic technology is part and parcel of this modern era. With the increasing use of electrical/ electronic instruments and devices, the electromagnetic emissions are also increasing. Thereby the problem of electromagnetic interference is getting more and more acute. Electromagnetic Interference (EMI) refers to an electromagnetic or electrostatic disturbance that causes malfunctioning or an undesired response in one or more electronic system, equipment or circuits. The electromagnetic interference is therefore vital concern for both maintainers and users. Hence the concept of electromagnetic compatibility arises. Electromagnetic compatibility (EMC) is the ability of equipment and systems to function as intended without degradation or malfunction in their intended operational electromagnetic environment. Marine ships and naval platforms use various types of electrical and electronic equipment such as navigational, communication, EW equipment/ systems and so on. This equipment is generating EMI and degrading the performance of the systems. Thereby it is necessary to know EMI mitigation techniques to reduce EMI and develop EMC.

Introduction

In 1986, when U.S. warplanes were ordered to strike Libya, they faced sudden electronic disturbances. Pentagon suspected this disturbance that led one fighter to crash and others to miss their targets. The Pentagon was so alarmed by the problem that it has launched a US$35million effort to find the source of the interference and stop it from happening again. Later, it was found that the disruption came not from the Libyans but from U.S. military transmitters. These

transmitters were designed to emit electronic signals in order to jam Libya's anti-aircraft defenses; hunt down targets, guided weapons and communication system.[1] This incident shows how an Electromagnetic Interference (EMI) can affect the safety of an electronic system. Actually, EMI is the interference caused by electrical and magnetic fields. The electromagnetic field produced by an electronic or electrical device interferes with another device, and thus it causes electromagnetic interference. The electromagnetic interference happens only when both the electrical and magnetic fields exist together. Two or more signal while travelling in parallel, produce the electric and magnetic field and radiate electromagnetic waves. The EM waves of one signal may interfere with other signals and vice versa. This phenomenon is called Electromagnetic Interference (EMI).[2]

Ships, submarines and aircraft have become mere platforms to house the multitude of highly sensitive and complex electronic weapons and communication system. Interference from electromagnetic sources has been a hazard onboard vessel with equipment such as converters, power panels, microprocessors, radar antenna etc. installed in very close quarters. In addition, there are kilometers of cables and other similar radiators and emitters. Coupling between various antennas and conductors contributes to various uncontrolled and undesired electromagnetic fields. Because of these complexities, EMI cannot be ignored any more to ensure success of any mission or operation. Generally, a marine/naval platform under construction should have equipment specified with compatibility regulations such as US Standard Federal Communications Commission (FCC), US Military Standard MIL-STD-461E,[3] European Standard International Special Committee on Radio Interference (CISPR)[4], etc. However, sometimes in the entire life cycle of that marine/naval platform, compatibility of its equipment is never checked. Moreover, vessels undergo repair, change of components, shielding, alterations, extra cabling and many of the linkages and joints become exposed to

1. Davisson G, (1989), 'F-111 downed by EMI?', 26 Jan 1989, accessed on 02 Sep 2023
2. https://www.electricalvolt.com/2022/03/emi-electromagnetic-interference-the-basic-fundamentals/, accessed on 18 Sep 2023
3. https://www.expando.se/everything-you-need-to-know-about-mil-std-461/, accessed on 18 Sep 2023
4. https://incompliancemag.com/article/history-of-cispr/, accessed on 18 Sep 2023

weather. Earthing efficiency also reduces over periods of time. Thus, achieving EMC is a great concern onboard ship. EMC must be achieved through design, production, maintenance, training/ awareness and using military standard/EMC standard equipment onboard naval ships and marine platforms.

Electromagnetic compatibility (EMC) is the ability of systems to function as designed, without malfunction or unacceptable degradation of performance due to EMI within their operational environment. Any electrical, electromechanical, or electronic equipment must not adversely affect the performance of any other equipment or system as a result of EMI and vice versa.[5] A few basic system components are frequently used to mitigate or suppress electromagnetic interference (EMI) in devices. The systems components used to reduce EMI are: Capacitors, Common Mode Chokes, Diodes, EMI Filters, Ferrites, Inductors, Resistors, etc.[6] It is an analytical article on EMI/ EMC and ways to control. There are plenty of information and literature related to EMI/EMC available both in library and in internet. Few studies have been carried out on available documents and practices on EMI/EMC. This paper discusses the background history of EMC and shipboard EMI sources. It also focuses on practical cases of EMI in complex systems and electromagnetic environmental effects. So, an effort has been taken to encompass few EMI mitigation techniques, ways to achieve EMC and challenges in maintaining EMC standards mainly in marine environment/ equipment.

Background History of EMC

The German physicist Heinrich Hertz performed experiments that demonstrated the phenomenon of radio wave propagation in the late 1880s. Hertz developed a spark in a small gap between two metal rods that were connected at the other end to metal plates, as shown in Figure 1. The spark excitation created an oscillating current on the rods resulting in electromagnetic radiation near the resonant frequency of the antenna. A spark in the gap indicated the presence of a

5. MacArthur D, (2018), "What Every Electronics Engineer Needs to Know About Filters," In Compliance Magazine, November 2018

6. https://www.emc-directory.com/community/what-is-the-difference-between-emc-and-emi? accessed on 18 Sep 2023

time-varying field and the maximum spark gap length provided a measurement of the received field's strength. In 1859 radio pioneer Guglielmo Marconi developed the wireless telegraph. This was the first communications device which sends information over radio waves. At the time this invention's significance was not appreciated by the general public as it is today. The U.S. Military, however, saw great potential in its use as a communication device for their ships. The U.S. Navy started using the wireless telegraph in 1899 and encountered one of the first known EMC problems. Because the transmitters were all tuned to the same operating frequency, no intelligible information could be received when operating more than one transmitter at the same time. This problem was dubbed Radio Frequency Interference (RFI).[7]

In 1904, Theodore Roosevelt signed an executive order empowering the Department of Commerce to regulate all private radio stations and the Navy to regulate all government stations (and all radio stations in times of war). Different types of radio transmitters were assigned different frequency allocations and often were only allowed to operate at certain times in order to reduce the potential for RFI. By 1906, various spark-quenching schemes and tuning circuits were being employed to reduce the bandwidth of wireless transmitters and receivers significantly. Later, in 1912 the invention of the vacuum tube oscillator and the invention of super heterodyne receiver in 1918 that made truly narrow band transmission and reception possible. These developments also made it possible to transmit reasonably clear human speech, which paved the way for commercial radio broadcasts. The period from about 1925 to 1950 is known as the golden age of broadcasting.

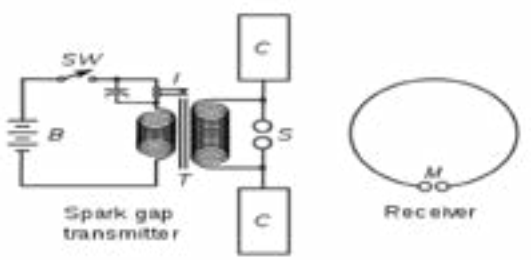


Fig 1: Early antennas constructed by Heinrich Hertz[8]

7. https://medium.com/@Shieldingshop/history-of-electromagnetic-compatibility-c1d3ea-b16a38, accessed on 18 Sep 2023

8. Jed Z Buchwald, (2011), The Creation of Scientific Effects - Heinrich Hertz and Electric Waves, University of Chicago Press, 2011

Due to the increasing number of radio receivers being located in homes, the general public was introduced to a variety of new EMC problems. Unintentional electromagnetic radiation sources such as thunderstorms, gasoline engines, and electric appliances often created bigger interference problems than intentional radio transmitters. Intra-system interference was also a growing concern. Radios were installed in automobiles, elevators, tractors, and airplanes. The developers and manufacturers of these systems found it necessary to develop better grounding, shielding and filtering techniques in order to make their products function. During World War II new types of radio transmitters and receivers were being developed to be used in the war. Radio signals were not only used for communication, but also to locate ships and planes (RADAR) and to jam enemy radio communications. Because of the immediacy of wartime, no extensive test was conducted and the equipment caused severe EMC problems on ships and planes as a result. At the end of the war the Navy issued the first RFI standard and EMC became a respected engineering specialization. In 1954 the Armour Research Foundation Conference on Radio Frequency Interference debuted. This conference still exists today under the name Electromagnetic Compatibility Society of the Institute of Electrical and Electronics Engineers (IEEE).[9]

During the 1960's, electronic devices and systems became an increasingly important part of the society and most importantly national defense. A typical aircraft carrier, for example, employed 35 radio transmitters, 56 radio receivers, 5 radars, 7 navigational aid systems, and well over 100 antennas. Thus, more attention on the issue of electromagnetic compatibility arose. Outside the military, an increasing dependence on computers, satellites, telephones, radio and television made potential susceptibility to electromagnetic phenomena a very serious concern. The 1970's witnessed the development of the microprocessor and the proliferation of small, low-cost, low-power semiconductor devices.

Shipboard Electromagnetic Interference (EMI) Sources

The origins of EMI are electrical, and that is with the unwanted emissions either conducted (voltages or currents) or radiated (electric or magnetic fields). For EMI occurrence, three essential elements need to be existed, like an electrical noise (EMI) source, a coupling path, and a victim receptor. The coupling path

9. http://www.shieldingshop.com, accessed on 19 Sep 2023

from a source to a receptor can be of four categories like, conducted (electric current), inductively coupled (magnetic field), capacitive coupled (electric field), and radiated (electromagnetic field).[10] However, the shipboard RF environment is a complex mixture of radiated electromagnetic energy created from multiple sources. The chief contributors are as follows :

a. **Onboard Emitters :** These are intentional or desired radiators of RF energy and include few systems like Transmitters, Radars, EW jammers, IFF transponders and Tactical air navigation (TACAN) homing beacons[11] etc.

b. **Extraneous Emitters :** These are radiators of RF energy not present onboard but on some external platform. They generate incoming useful RF transmission (e.g. communications, navigation data, IFF) from friendly external sources, extraneous RF Transmissions (e.g. radar transmissions) from ships in proximity and undesired deliberate RF transmissions from unfriendly sources (e.g. energy surveillance and jamming etc).[12]

c. **Natural RF Sources :** These include phenomena like lightening, galactic and atmospheric noise.[12]

d. **Man-made Source :** These including unintentional source of EM energy like electrical machinery and components.[12]

Diagnose EMI Problem

Besides identifying the sources, it is very essential to find coupling path of EMI to diagnose an EMI problem. The source is usually identified by examining the type of interference which is plugging the receiver. The most often overlooked component is the coupling path through which source is coupled with the victim through a radiated path, conducted path, or a combination of both. Without the coupling path, an interference condition does not exist; therefore, breaking this path is pre-requisite to ensure that EMC is achieved. These phenomena are discussed below :

10. Gerke Daryl, et al, (1994), EDN's Designer's Guide to Electromagnetic Compatibility, vol. 39, no. 2, January 20, 1994

11. Indian Navy (2011), Training Handbook, Mumbai -400001: Naval EMC Centre, accessed on 19 Sep 2023

a. **Conducted Emissions (CE) :** Conducted Emissions (CE) can be defined as the flow of electromagnetic energy out of a device, equipment, system (source) through the conducted path i.e. through leads (wires or cables) coming out of the source. The devices, equipment, systems connected to these leads can become victims of these emissions.[12]

b. **Radiated Emissions (RE) :** Radiated Emissions (RE) can be defined as the flow of electromagnetic energy out of a device, equipment, system (source). The radiated path can be through antennas, cables acting as radiating elements, or through apertures in the units, cabinets, housing of the source.

c. **Conducted Susceptibility (CS) :** Conducted Susceptibility (CS)can be defined as the weakness or vulnerability of device, equipment, systems (victims) to get affected by existing emissions via the conducted path i.e. conducted emissions generated by some source to which they are connected. This parameter describes the Electromagnetic Vulnerability (EMV) of the victim. The victim should be suitably 'hardened' electromagnetically to prevent the debilitating effect of EMI.

d. **Radiated Susceptibility (RS) :** Radiated Susceptibility (RS)can be defined as the weakness or vulnerability of device, equipment, systems (victims) to get affected by existing emissions via the radiated path i.e. radiated emissions generated by some source in whose vicinity, path these devices, equipment, systems exist.

EMI Effects on Electronic Systems

EMI can be caused by natural or human-made sources. Using high quality electronics, electrical shielding, and modern error correction can reduce the impact of EMI. A common example of EMI is when a mobile phone is placed near powered audio equipment or speakers, and it causes a noise or series of beeps to be heard. EMI occurs because of the close relationship between electricity and magnetism. All electrical flow produces a small magnetic field. Conversely, a moving magnetic field produces an electrical current. These principals allow electric motors and generators to work. Additionally, all electrical conductors can

operate as radio antennas.[12] As electronics become smaller, faster, more tightly packed and more sensitive, they become more susceptible to these effects, causing EMI.[13] There are some sources in the natural world that can produce powerful electric fields to affect electronic devices. Lightning can produce strong electrostatic discharges and magnetic pulses. Solar storms and solar flares emit highly charged particles that can cause problems with satellite and terrestrial communications. Cosmic radiation has been known to cause bitflips in electronics.[14] Human-made EMI can come from many places. High-power radio and electrical sources can cause unwanted EMI. Malfunctioning or improperly designed consumer devices can cause EMI in other devices. Again, using an electromagnetic pulse to intentionally induce EMI faults in victim devices is also a possible offensive action.[15] Few case studies has been given below for better understanding of EMI affect :

a. **Effect of LED Light :** Floodlights were very popular on boats that had to work at night, and LED light bulbs were seen as a way to save money when the first LED light bulbs came out. To save energy, many fishing boats have switched from light bulbs to LEDs. But a few months later, accidents happened because it turned out that these LED lights were not very good from an EMC (Electromagnetic Compatibility) point of view and messed up the navigation equipment, especially the VHF channels.[16]

b. **Influence on a DGPS Receiver :** At a new built vessel, the reception of the DGPS signal was not possible due to emissions from an air conditioner and some switching components, which were not properly grounded. After the grounding was corrected and also when the air conditioner was switched off, the DGPS receiver did not interfere anymore.[17]

12. https://www.techtarget.com/whatis/definition/conductor, accessed on 19 Sep 2023
13. https://www.techtarget.com/searchmobilecomputing/definition/electromagnetic-interference#, accessed on 19 Sep 2023
14. https://www.scienceabc.com/innovation/what-are-bit-flips-and-how-are-spacecraft-protected-from-them.html, accessed on 19 Sep 2023
15. https://www.techtarget.com/whatis/definitions/E, accessed on 19 Sep 2023
16. Dolphin charger, (2022), 'How to prevent Electromagnetic Interference for marine vessels?', accessed from https://www.dolphin-charger.com/news/electromagnetic-interference-marine-vessels, on 19 Sep 2023
17. C. Klünder T et al, (2010), "Modern Vessels and their Problems in EMC –," in IEEE, 2010, accessed on 19 Sep 2023

c. **Malfunction of Medical Equipment :** A 93-year-old heart attack victim died when the attached monitor and defibrillator shut down every time the radio transmitter was used in an ambulance. This was due to the metal fiberglass ambulance roof that allowed high levels of radiated radio fields inside the patient area of the ambulance. This radio field was the cause of shutting down monitor and defibrillator.

d. **Accidental Firing of Ammunition from An Aircraft :** In 1967, a military aircraft was exposed to ships radar that caused it to accidentally fire its ammunitions, hitting another armed aircraft sitting on the outer deck of the same ship. This accident was a result of an EMI case, as investigations revealed that a degraded cable shield termination on the first aircraft, caused emissions that interfered with the radar and hence operation of the aircraft causing it to misfire.[18]

e. **Walkie-talkie Interferes with Ship Steering, Causes Minor Collision :** An incident occurred outside United Kingdom (UK) waters where there was a minor collision between a supply vessel servicing a semi-submersible offshore oil and gas installation. The vessel experienced a sudden power increase brought on because of interaction between radio signals from a portable VHF radio and the joystick control. This caused the joystick to execute commands not requested by the operator and resulted in contact between the vessel and the installation. The interaction caused minor damages.[19]

f. **Power Down Case of US Navy Vessel :** Once a U.S. Navy vessel was at full power while underway, suddenly an unexpected power shutdown occurred. It was found that high frequency (HF) transmissions caused an oil pressure sensor to falsely sense a low reading. Before engineers could intervene, the false signal caused a shutdown signal in the automated power control system.[20]

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18. P. E. Law, (1987), Shipboard Electromagnetics, Dedham MA: Artech House, 1987, accessed on 15 Aug 2023
IEC 60533, (2015), "Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull.," IEC, Geneva, 2015, accessed on 13 Aug 2023

19. Banana Skins, (2014), The first 855, 30 December 2014, accessed on 01 Sep 2023

20. Personnel communications with Ken Javor, Sverdrup Technologies, Huntsville, AL, accessed on 01 Sep 2023

g. **H.M.S. Sheffield Catastrophe :** During the Falklands War, the British Ship H.M.S. Sheffield sank with heavy casualties after being hit by an Exocet missile. Despite the Sheffield having the most sophisticated anti-missile defense system available, the system created electromagnetic interference to radio communications to and among the contingent of Harrier jets assigned to the ship. While the Harriers took off and landed, the missile defense was disengaged due to EMI and this allowed communications with the jets and provided a window of opportunity for the Exocet missile.[21]

h. **UH-60 Blackhawk Case :** An Army Sikorsky UH-60 Blackhawk helicopter, while flying past a radio broadcast tower in West Germany in 1987, experienced an un-commanded stabilator movement. Spurious warning light indications and false cockpit warnings were also reported. Subsequent investigation and testing showed that the stabilator system was affected by EMI from high intensity radiated fields (HIRF). The Blackhawk has a conventional mechanically linked flight control system with hydraulic assist. The stabilator system, however, uses transmitted digital signals to automatically adjust its position relative to control and flight parameters. These digital signals are highly susceptible to HIRF. Between 1981 and 1987 five Blackhawk helicopters crashed and killed or injured all on board. In each crash, the helicopter flew too near radio transmitters. The long-term solution was to increase shielding of sensitive electronics and provide an automatic control reset backup.[22, 23]

j. **Explosion of S&T Daewoo K11 Rifle :** On October 2011, a Korean news website revealed that S&T Daewoo K11 rifle exploded after one of its 20mm grenades was prematurely detonated. The soldier who was operating the gun suffered cuts on his hands and face. The Korean Department of Defense addressed the problem as electromagnetic interference from the Fire Control System. The transmitter which sends trigger signal to ammunition fuse was not properly fixed because of design defect. The shooter squeezed trigger a little before the firing, it interacted with not properly positioned

21. Von Achen W, (1991), "The Apache Helicopter: An EM1 Case History." Compliance Engineering, Fall, 1991, accessed on 01 Sep 2023

22. Mordoff K. P., (1988), "UH-60 Helicopters to Be Modified For Increased EM1 Protection." Aviation Week and Space Technology, October 10, 1988, pp- 75-77, accessed on 01 Sep 2023

23. Axelrod P., (2990), "Disaster Signals: Suicidal Weapons." International Perspectives in Public Health, vol. 6, 1990, pp- 10-20, accessed on 03 Sep 2023

transmitter and sent wrong signal to 20mm ammo fuse. It caused 20mm round explosion in the barrel.[24]

Electromagnetic Environmental Effects

The above-mentioned cases indicate how EMI can be hazardous for equipment and weapon. Besides, high intensity RF fields can cause detrimental effects on personnel, fuel and ordnance. As a whole, these can be termed as Hazards of Electromagnetic Radiation to Personnel (HERP), Hazards of Electromagnetic Radiation to Ordnance (HERO) and Hazards of Electromagnetic Radiation to Fuel (HERF). These effects are explained below :

a. **Hazards of Electromagnetic Radiation to Personnel (HERP) :** Electromagnetic energy interacts with tissues in human beings to produce biological harmful effects. The degree of damage depends upon factors like intensity, frequency, high energy photons, polarization, duration of exposure, etc.[25] The following table shows how machineries and equipment onboard can be hazardous to human bodies according to their radiation level :

Frequency MHZ	Wavelength (cm)	Site of major tissue effects	Major biological effects
100	Above 200	Not established- Probably whole body	General warming of exposed areas (used in Diathermy)
150-1200	200 - 25	Internal Body Organs	Damage to Internal Organs from Overheating
1000- 3300	30 - 10	Lens of the Eye	Lens of the Eye particularly susceptible and tissue heating
3300-10000	10 - 3	Top layers of the Skin, Lens of Eye	Skin heating with the Sensation of warmth
10-100 GHZ	Less than 8	Skin	Skin surface acts as reflector or absorber with heating effects
Damaging levels vary with frequency, ambient temperatures, and individuals. Safety criteria establish levels above 10 MW / cm^2 at any frequency as being unsafe.			

Table 1- Biological effects of microwave damaging levels [26]

24. Johnson S, (2012), Electromagnetic Interference caused K-11 KABOOM, 08 May 2012, accessed from https://www.thefirearmblog.com/blog/2012/05/08/electromagnetic-interference-caused-k-11-kaboom/, accessed on 03 Sep 2023

25. H Levitt, (2001), The nature of electromagnetic interference, American academy of Audiology, 2001, accessed on 17 Aug 2023

26. Gordon Z. V., (1970), Occupational Health Aspects of Radiofrequency Electromagnetic Radiation. In: Ergonomics and Physical Environmental Factors, Geneva, International Labour Office, pp- 159-174, (Occupational Safety And Health Series No- 21), accessed on 03 Sep 2023

In order to control the biological hazards from electromagnetic radiation, necessary actions are to be taken.[27] These actions include management of personnel, equipment design, necessary constraints or radiation fences and using abundant warning signs at possible hazardous locations.[28]

b. **Hazards of Electromagnetic Energy to Ordnance (HERO) :** Modern radio and radar transmitting equipment produce high-intensity electromagnetic fields. Such fields can cause premature actuation of sensitive electric explosive devices (EEDs) contained in ordnance systems. Electromagnetic energy can enter ordnance items through a hole or crack in its skin or may be conducted into it by firing leads, wires, screw drivers, fingers and so forth.[29] In general ordnance systems that have proved to be susceptible to Radio frequency energy are most susceptible during assembly, disassembly, loading, unloading etc.[12]

c. **Hazards of Electromagnetic Radiation to Fuel (HERF) :** The principal hazard to fuels from electromagnetic radiation exists when aircrafts are being re-fueled on the deck of aircraft carriers in proximity to high powered radiating transmitting antennas. Hazards also exist when certain low vapor pressure fuels are carried in sealed trucks subject to liquid agitation which produces electric charge build-up in the fuel and subsequent electrostatic discharge inside the tank causing an explosion if, the internal mixture of fuel vapor and air is suitable.[30] Fuel servicing equipment should be operated and maintained to minimize the possibility of accidental spills. Radiating devices shall be installed such that they do not illuminate the area where fueling is in progress. Radar and other transmitting devices should not be operated during fueling or de-fueling operations.[31]

27. B V Leersum, (2016), "Requirements with rationale and quantitative Rules for EMC on future ships," 2016, accessed on 01 Sep 2023

28. F Leferink et al, (2017), "An interference risk–based approach for naval vessels," in Ship Science & Technology, Colombia, 2017., accessed on 14 Aug 2023

29. Guide for the EMC Directive, (2014, accessed from https://ec.europa.eu/docsroom/documents/28323, accessed on 10 Aug 2023

30. P. O. Alexander et al, (195), "Electronic Systems Failures and Anomalies Attributed to Electromagnetic Interference," NASA Report 1374, National Aeronautics and Space Administration, Washington, July 1995, accessed on 23 Aug 2023

31. C Klünder, et al, (2010), "Modern Vessels and their Problems in EMC..," in IEEE, 2010, accessed on 03 Sep 2023

EMI Mitigation Techniques

A few basic system components are frequently used to mitigate or suppress electromagnetic interference (EMI) in devices. It is important to know what these components are, what they do, how they are most effective, and when they are ineffective. The systems components used to reduce EMI are: Capacitors, Common Mode Chokes, Diodes, EMI Filters, Ferrites, Inductors, Resistors, etc.[32] However, it is not always possible to anticipate, mitigate and eliminate all potential interference situations through ship design and equipment design. Therefore, EMI reduction technique is very necessary and which interferences are discussed as follows :

a. **Bonding :** Bonding refers to the process by which a low impedance path for the flow of electric current is established between two metal objects. The function of a good bond is to increase the area for current flow, thus minimizing the bond resistance.[33] There are basically two types of bonding namely direct and indirect bonding.[12] Direct bonding means creating an electrical route between interconnecting members without using an auxiliary conductor. Direct bonding includes bus bar splices, lightning down conductor-earth electrode connections, equipment front panel-rack mating, and connector shell-panel installation. Direct bonding is often not possible because of how the equipment is used or where it is located. Bond straps or cables are often used to stop static electricity from building up and to connect metal items to lightning down conductors to stop flashover as indirect bonding.

b. **Grounding :** Grounding is another recognized way of mitigating electromagnetic interferences. Grounding is the process of establishing the required low impedance or low resistance path between an item or equipment and ground potential by the specified methods. It ensures personnel safety and prevent shock dangers or death in the event that an equipment develops a high potential due to illumination, a high external transient or a power fault

32. https://www.emc-directory.com/community/what-is-the-difference-between-emc-and-emi, accessed on 19 Sep 2023

33. https://ieeexplore.ieee.org/abstract/document/8169091, accessed on 19 Sep 2023

to the case, etc.[34] It provides a reference for signals used to communicate between equipment. There are three types of grounding which are as follows.

(1) **Floating Signal Ground :** Generally floating signal ground system is electrically isolated from the hull. Hence, noise currents present in the hull ground system will not be conductively coupled to the signal circuits.

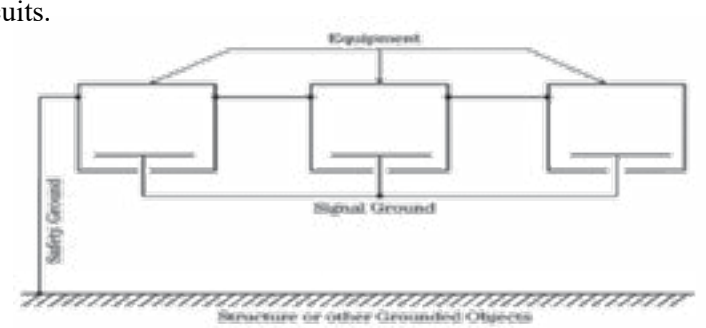


Fig 2: Floating Signal Ground[35]

(2) **Single Point Ground :** Single-point signal ground network is one in which separate ground conductors extend from one point on the hull ground to the return side of each of the numerous circuits located throughout the ship.[12] This type of ground network required an extremely large number of conductors and is not generally economically feasible.

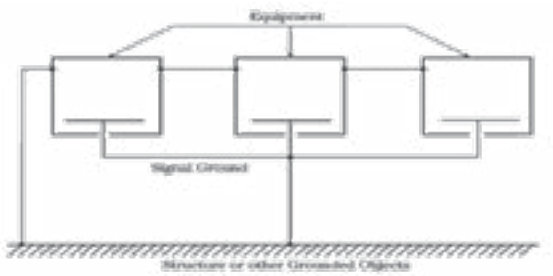


Fig 3: Single-Point Signal Ground[36]

34. https://ieeexplore.ieee.org/abstract/document/950507, accessed on 19 Sep 2023
35. https://eepower.com/technical-articles/single-point-and-multi-point-signal-grounding/, accessed on 19 Sep 2023
36. https://interferencetechnology.com/designing-electronic-systems-for-emc-grounding-for-the-control-of-emi-3/, accessed on 19 Sep 2023

(3) **Multiple Point Ground :** The multiple point ground uses many conductive paths from the hull to the various electronic systems or subsystems within the ship. Within each subsystem, circuits and networks are connected to this ground network.

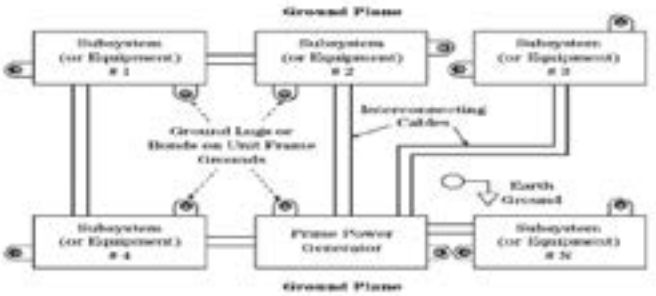


Fig 4 : Multiple-Point Ground Configuration[37]

c. **Shielding :** Shielding is a means of de-coupling and thus, reduces interaction between equipment. Properly designed and installed shielded enclosures can be a very effective means of attenuating radiated emissions and protecting products from external sources of interference. Shielding effectiveness is the result of reflection losses and penetration losses together. At frequencies as low as 60 Hz, penetration loss and reflection loss become negligible for magnetic fields so that, for lower frequencies, very thick metallic barrier may be necessary to shield against magnetic fields. Since magnetic material, have high permeability at low frequencies, and therefore high penetration loss, they are more effective as shields for low frequencies.[38] The resulting increases in penetration loss are obtained at the expense of a reduction in reflection loss. In this case, a correction factor(B) which accounts for the effect of successive re-reflections must be added. The total shielding effectiveness(S) becomes :

S = A + R + B where S = Shielding Effectiveness; A = Penetration or absorption loss in dB of the shield; R = Total reflection loss in dB from both surfaces of the shield; B = Positive or negative correction factor when A < 10.

37. https://www.researchgate.net/figure/Multipoint-Grounding-System_fig5_335961696, accessed on 19 Sep 2023

38. https://ieeexplore.ieee.org/abstract/document/8331137, accessed on 19 Sep 2023

Again, the wave energy that penetrates the shielding suffers a penetration loss which is related to the type and thickness of shielding material. Reflection losses are independent of shielding thickness. The penetration loss, also known as absorption loss, can be defined as follows:
$A = 3.34(10^{-3t}\sqrt{f\mu_r\sigma_r})$ Where, A= Absorption loss in decibels; t = shield thickness in miles; f = frequency in hertz; μ_r= permeability relative to μ_0 andσ_r = conductivity relative to copper.

d. **Filtering :** Filters are combination of circuit components designed to pass currents at certain frequencies or to attenuate currents at other frequencies. They utilize the response characteristics of series and parallel combinations of inductance and capacitance. This reactance reduces interference by introducing high impedance in series with the interference currents and/ or shunting interference currents to ground through low impedance.[39]

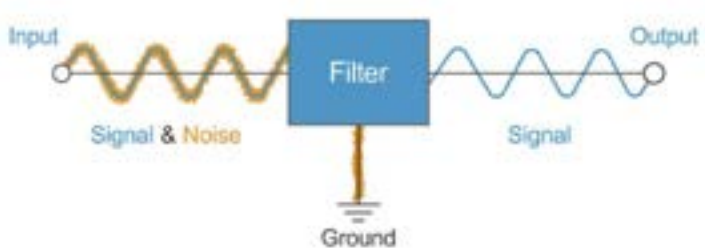


Fig 5: EMI filtering for high reliability[40]

Ways to Achieve EMC Capabilities

Electromagnetic compatibility (EMC) is the ability of an electronic system to operate within an electromagnetic environment satisfactorily without generating intolerable EMI (Electromagnetic Interference) in nearby devices/ systems. EMC ensures that the system must perform as intended under the defined safety measures.[41] The electromagnetic interference caused by different sources

39. https://ieeexplore.ieee.org/abstract/document/4591923, accessed on 19 Sep 2023
40. https://www.powerelectronictips.com/emi-control-for-power-and-signal-lines-faq/, accessed on 19 Sep 2023
41. Paul, C.R., et al, (2023), Introduction to Electromagnetic Compatibility, 3rd Edition, John Wiley & Sons, 2023

along with their coupling paths is vital concern which needs to be addressed and mitigated. Hence the concept of electromagnetic compatibility (EMC) arises. Electromagnetic compatibility (EMC) addresses two concerns. First, the ability of a device to limit its radio frequency emissions so it doesn't interfere with other nearby devices (for example radio receivers) and second, the ability of a device to operate as required in the presence of electrical and electromagnetic interference and other electrical hazards.[17] Besides, it would be impossible to implement EMI without maintaining good EM hygiene onboard ships. Moreover, care should be taken to achieve EMC through design, production, maintenance and military standard equipment. The following ways leads to probable solutions to achieve EMC through aforesaid perspectives :

a. **Design Phase :** EMC standards are to be strictly maintained from the initial stage of designing any vessel/ ship. Care should be taken during installations of various radio equipment, radars, antenna, communication equipment and cable routing etc.

b. **Production Phase :** EMC standards are to be ensured during production of any equipment/ machinery. Besides, EMC compliance certificates can be sought while buying vessels or machineries from OEM.[2] Before commissioning of a ship and after all the HATs, top deck visual survey, below deck visual survey, ground discontinuity test, radiation hazard measurement etc. should be carried out.

c. **Maintenance Phase :** To ensure EMC, ship staff can follow an EMC work package which can be implemented during the refit and after the completion of refit.[12] To avoid any problems, the following steps can be followed during maintenance period :

(1) Check the EMC specifications given by the equipment manufacturer.

(2) Ensure the exact location of installation to which the EMC certification is linked.

(3) If in doubt, request test reports from the manufacturer to obtain proof of compliance.[17]

d. **Training and Awareness :** EMI / EMC should be considered as specialized subject. Concerned personnel should be trained at regular interval through various professional courses. Seminars and workshops can be conducted at the various commands, dockyards, shipyards and professional schools at regular intervals to educate specific target audiences on EMI / EMC.

e. **Military Standards :** The electromagnetic environment onboard ships are considerably more complex than that for a commercial product. To prevent EMI effects, all machineries are to be according to certain EMC standard. Generally, a vessel under construction should have equipment specified with EMC standard compatibility regulations such as US Standard Federal Communications Commission (FCC), US Military Standard MIL-STD-461E: 1999, European Standard International Special Committee on Radio Interference(CISPR), etc.

f. **Check off List :** Marine and naval platforms are using various types of electrical and electronic equipment such as navigational, communication and EW equipment/systems onboard naval platforms. EMI / EMC auditing defines the check off lists, restraints and constraints which are applicable to reduce EMI of ship's hull and structure, communication system, radar system and EW system. Regular follow up of check off list, restraints and constraints of ship's hull and structure, communication system, radar system and EW system in terms of EMI / EMC may improve the performance of the equipment onboard naval platforms. However, following conditions are to be satisfied by ship's personnel for achieving electromagnetic compatibility :

Hull and Structural	Communication System
a. All bimetallic joints throughout the ship carefully are to be inspected and actions to be taken to prevent corrosion.	a. Communication receivers are to be connected to antennas through matching networks and filters whenever possible to minimize harmful interference.

Hull and Structural	Communication System
b. All lifelines, ladders, davits, shrouds, stays and other topside hardware are to be properly installed and grounded. c. All onboard personnel are to be briefed to report any arcing observed in topside areas. d. All personnel are to be cautioned to avoid applying paint, varnish, grease or other contaminants to any insulator.	b. Communication equipment is to be operated with all doors, vents and panels closed and all equipment RF boundaries are to be intact. c. Communication equipment rooms are to be properly ventilated and/ or air conditioned, and fans can be installed where required. d. Communication system antennas are to be inspected regularly.

Radar System	Electronic Warfare System
a. All blind zones, shadows, beam pattern irregularities and obstructions must be identified for all radar antennas across their frequency range and these findings are to be used to establish optimum operating frequencies. b. Radar equipment rooms are to be properly ventilated and/ or air conditioned and fans are to be installed where required. c. All radar elements are to be free from contamination, cracks and chips. d. Radiation safety and EMI control training are to be included in the radar systems training plans, conducted regularly and documented in the radar systems training records. e. Waveguides and other components are to be regularly inspected for corrosion, loose fittings, and damage.	a. Blind zones are to be identified (if applicable) for all EW systems antennas. b. EW equipment is to be operated with all doors and panels closed and RF boundaries are to be intact. c. EW equipment rooms are properly ventilated and/ or air conditioned and fans are to be installed where required. d. Waveguides and other components are to be regularly inspected for corrosion, fittings and damage. e. All EW systems antennas are to be bonded and grounded, free of corrosion, mechanically sound, well maintained and properly lubricated.

g. **PCB Design :** Printed Circuit Board (PCB) is the indispensable part of modern electronics. Electromagnetic compatibility is paramount while designing PCB. A PCB trace is to connect any kind of electrical signal, whether it be analog, digital, or power, from one terminal to another terminal. EMI can be reduced in PCB's in two ways namely, reducing coil/ loop area and minimizing the rate of change of current. When loop area decreases, the magnetic flux will also reduce. Faraday's law states that the magnetic field generated by a coil is directly proportional to the area of the coil and the current. As we know that, E = di/dt∝ Coil Area ∝ Current going through the coil. On the contrary, reducing coil/loop area is more challenging because of its size. A standard trace width for an ordinary signal (no special requirements) may be in the 7-12 mil range while a mil is equal to 1000th part of an inch. The second thing is minimizing the rate of change of current since higher current causes more emissions. So, if current is reduced, EMI can also be reduced. Maintaining appropriate coil length and low rise times, even if the PCB is operating at high frequency, it can also be helpful for EMI reduction.[42]

Testing EMI / EMC, PCB Design and Meeting EMI / EMC Standards

EMC compatibility depends upon three perspectives like, it should not interfere with other systems, it should not show sensitivity to emissions from other systems and, most importantly, it should not cause interference with itself. On the contrary, electromagnetic compatibility of any electronic circuitry is associated with the generation, propagation, and reception of electromagnetic noise. Electromagnetic noise is not a welcomed character in any PCB, equipment or machinery. Intensive care is to be ensured so that signals do not interfere with each other when it comes to traces, vias, and even PCBs.

To meet EMC requirements, the device must be tested for conducted and radiated emissions along with conducted and radiated susceptibility. The electromagnetic emissions in an electronic system are measured by implementing

42. ISO 7637-3:2007 – Road vehicles – Electrical disturbances from conduction and coupling – Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines, Iso.org (2010-09-06), accessed on 19 Sep 2023

various modeling techniques. These test outputs indicate to define permissible limits for both conducted and radiated emissions and their classification into residential, commercial, light industrial and industrial environments. The ultimate objective of EMC standards is to maintain compatibility between the co-located electrical and electronic system for trouble-free operation.

Any electronic circuit consists of several electronic components arranged in a pre-defined manner.[43] If the arrangement is improper, it may result in EMI/ EMC complications. PCB layout has a significant impact on EMC performance and the quantity of EMI generated by any component. While designing a PCB, we must consider the EMI/EMC effect of each component. Good EMC performance can only be attained through good PCB design practices, in which the designer must either eliminate the interference source or shield the circuit from its adverse effects. Eventually, the goal is to maintain the intended functionality of the circuit board for better EMC.[44] EMC improvements with accurate PCB design do not add extra cost to the final product. That is why it is recommended to have all considerations on EMC standard during the initial production phase of PCB.

Challenges for Maintaining EMC Standards

The future of electromagnetic compatibility (EMC) standards is likely to be shaped by a number of emerging trends and technologies. Some of the challenges due to key trends and technologies are as follows :

a. **Complexity due to New Technologies :** With each passing day, an increasing number of newer technologies are being developed and introduced. It might be challenging to adhere to a single set of standards when confronted with emerging technologies. Therefore, the standards for electromagnetic compatibility (EMC) have to undergo regular and ongoing revisions and updates. Besides, the maintenance of EMC standards can provide challenges, especially when dealing with electronic devices that comprises of several components or systems.

43. Clayton Paul, (2008), Introduction to electromagnetic compatibility, Wiley, Pp-10, ISBN 978-81-265-2875-2, accessed on 19 Sep 2023

44. https://www.protoexpress.com/blog/7-pcb-design-tips-solve-emi-emc-issues/, accessed on 19 Sep 2023

b. **Changing Standards :** EMC standards are subject to change over time in new testing equipment or procedures. Generally, the new EMC standards are tested frequently within controlled laboratory settings, which may not fully replicate the real-world conditions under which the device or weapon is intended to operate. This can pose challenges in accurately forecasting the device's or weapon's performance in real-world conditions.

c. **Increased Use of Radio Web :** As the utilization of radio communications continues to expand, the significance of EMC standards will progressively escalate.

d. **Satellite Communication :** Modern world is focusing on satellite communication more than ever before. Internet and telecommunication through satellites may be trending in near future. Nowadays, Star link project, created by Space X, a private company led by Elon Musk is using bunch of satellites up in space to make the internet work better for everyone. As a result, the presence of satellites, along with their corresponding ground communications and control equipment, as well as their operational activities, can significantly contribute to the generation of electromagnetic interference (EMI).

e. **Increased Number of Electronics Users and Maintainers :** People are using electronic gazettes and machineries frequently. Due to their continuous involvements, EMI is increasing. In such circumstances, the implementation of automated equipment and machinery and reducing human involvement can provide significant improvement of electromagnetic compatibility.

f. **Involve Additional Cost :** The process of maintaining electromagnetic compatibility (EMC) can incur significant costs, particularly for electrical equipment that are vast in size or possess intricate designs. Ships may be required to allocate resources towards the acquisition of specialized equipment and staff, resulting in a rise in overall expenses.

Conclusion

Embedded systems can exist in environments that are very insensitive and noisy, that can lead to potential problems with electromagnetic interference (EMI). EMI consists of any unwanted, spurious, conducted, or radiated signals of electrical origin that can cause degradation in equipment performance. As a result, all components must comply with specifications to ensure electromagnetic compatibility (EMC), and there are several design methods that can be used to prevent EMI. During the development life cycle of an embedded system, the product must be designed to comply with EMC standards as describe above, and the product must be tested for EMC for better performances. During different missions, experiencing electromagnetic interference can be a very stressful. The above-mentioned case studies of EMI clearly state how a mission's success can be jeopardized in certain circumstances. Nearly every electronic system onboard any marine or naval platform has a chance of being damaged by electromagnetic interference (EMI), which is created by another device onboard. As modern ships have been equipped with a greater number of antennas and extremely sensitive systems, this issue has been a persistent challenge for contemporary fleets.

However, these challenges can be solved using appropriate equipment. Since EMI issues are becoming more common, modern navies and marine platforms are more focused on EMC standards. EMC standard helps to ensure regular practice of EMI mitigation techniques like bonding, grounding, shielding and filtering. Besides EMC standard helps in reducing and controlling issues connected to EMI. Marine and naval ships may initiate practicing above discussed check off list, imperatives of Hull and Structural System, Communication System, Radar System and EW System to achieve desired EMC. Besides, EMC can be achieved through design, production, maintenance, training and awareness programs. This awareness will lead to positive changes in manpower regarding use of electronic devices, equipment and their maintenance. However, with electronic devices getting smaller, faster, and increasingly more complex, EMC standards are also evolving regularly. Designing with EMC standards is to be established as a norm, rather than a frustrating afterthought. Thus, EMC standards are to be prioritized and emphasized more around the world.

Biography of the Writer



Rear Admiral Khandakar Akhter Hossain, NUP, ndc, psc, PhD was commissioned in the Engineering Branch of Bangladesh Navy on 01 January 1991. He has completed his 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 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 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 Institution of Science and Technology(MIST). 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, Al, 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.



Commander Sajia Sultana, (L), psc, BN was commissioned on 21 December 2001 in Electrical Branch from Bangladesh Naval Academy (BNA). She completed her BSc (Engg) in Electrical and Electronic Engineering from Khulna University of Engineering and Technology (KUET) in 2005. She completed her Long Electrical Specialization Course (LEC) from BNS SHAHEED MOAZZAM, Kaptai in 2010 and Junior Staff Course from Bangladesh Naval Academy in 2011. She served onboard various ships and establishments in various capacities. She served as Deputy Electrical Officer (DLO) on board BNS OSMAN, as Instructor NBCD School, BNS ISSA KHAN, as Section Commander at Drafting Authority Office at Naval Headquarters. She did her UN Mission from Central African Republic as Staff Officer. She also served as Electrical Officer onboard BNS SOMUDRA JOY. She attended EMI/ EMC Course at INS VALSURA in India. Currently she is serving as DGM (Ordnance) at CSD Organization.



Lt Commander Mossammat Fatema Akter Royida, (L), BN was commissioned in Bangladesh Navy on 21 December 2014 in Electrical Branch. She completed her B.Sc (Engg) in Electrical, Electronics and Communication Engineering from Military Institute of Science and Technology (MIST) in 2018. She completed her Junior Staff Course from Bangladesh Naval Academy in 2020 and Long Electrical Specialization Course (LEC) from BNS SHAHEED MOAZZAM, Kaptai in 2021. She has served as Electrical Officer in various establishments and dockyards of Bangladesh Navy. She has attended Basic Military & Peacekeeping Training Course at Abu Dhabi, UAE and Machinery Tuning and Equipment Control Course at INS SHIVAJI in India. Presently she is working as OIC Battery and Electroplating Shop and Manager Ship Repair (Weapon & Electrical) at CSD organization.

BEIRUT BLAST 2020 : THE MOST DEVASTATING EXPLOSION IN HISTORY

Commodore Mohammad Joynal Abedin, (ND), NGP, ndc, afwc, psc, PhD, BN

Abstract

The Beirut Port explosion on 4th August 2020, the most catastrophic incident in the recent history of disaster in the world, has been depicted with the attestation of an eye-witnessing experience in the article, specially from the perspective of the immediate action plan of disaster management and impediment caused-by. Bangladesh Navy Ship BIJOY deployed in Lebanon, as one of the naval units of UN Maritime Task Forces, was berthed at Beirut Port at the moment of the explosion. Around 400 meters North of BNS BIJOY, a small fire broke out in the Port's warehouse storing about 2750 tons of ammonium nitrate. Having simply been informed about the small fire incident and sensed something otherwise, I rushed with a bicycle to the place to observe the situation. Instantly after going there, I started returning, since the fire was getting increased drastically. When I was about 50 yards away from our ship BNS BIJOY, the explosion took place. The havoc of the blast destroyed everything in the port and the city nearby and grounded almost everything, causing at least 200 deaths, over 7000 injuries and damaging properties of USD 10 to 15 Billion. BNS BIJOY had to endure severe injuries to personnel and damages to materials. In the course of evacuation and controlling the damage, the initiatives taken by the ships' leadership, UNIFIL HQ and Bangladesh Navy Headquarters have remarkably been effective not only for BNS BIJOY, but for the entire area of the incident as well, keeping the whole range of lesson learned for future generations. Besides the lessons, a mere story narration of this article would touch the reader and carry them forward fur into the future in their memories.

Introduction

On 04 August 2020, a large amount of long-stored ammonium nitrate at the port of Beirut, the capital of Lebanon, exploded causing at least 200 deaths, a few reported missing, over 7000 injuries, damaging property of US$10–15

billion, and leaving an estimated 3,00,000 people homeless. About 2,750 tons of ammonium nitrate (equivalent to around 1.1 kilotons of TNT) confiscated by the Lebanese authorities from the abandoned ship MV RHOSUS, had been stored in a warehouse without proper safety measures for the previous six years. The explosion was preceded by a fire in the same warehouse, but till now (as of September 2023), the exact cause of the detonation is under investigation. The explosion was felt in Turkey, Syria, Israel, Palestine, and parts of Europe, and was heard in Cyprus which is more than 150 miles away. It was detected by the United States Geological Survey as a seismic event of magnitude 3.3 and is considered one of the most powerful non-nuclear explosions in history. Bangladesh Navy Ship BIJOY deployed in UNIFIL as one of the Maritime Task Force units was berthed at Beirut for a port of call just in the morning of the day of the explosion. The ship was severely affected by the explosion. The sudden shock wave created from the explosion caused severe damage to the ship leaving about 36 of the crew injured of which a few of them were found in severe condition.



Figure 1 : Initiation of fire incident to aftermath of Beirut blast

During the explosion BNS BIJOY was secured alongside pier number 06 about 400 meters away from the area of the explosion. The huge explosion caused material damage and human injuries to the ship. The explosion played havoc around vast areas across the Beirut city. As the ship was berthed close to the explosion area, it had experienced the grave blow of the explosion. Office of UNIFIL Headquarters and Bangladesh Naval Headquarters were deeply concerned for the affected ship and her crew. The various crucial events aftermath of the explosion such as damage to the ship, casualty evacuation, medical treatment for the injured personnel, Navy high delegation team visit, UNIFIL high officials' visit and their consecutive actions, friendly offer for repairing and docking of the damaged ship by Turkish Government etc. remain in memory as well as lessons for the future.



Figure 2 : Beirut port before the blast and its location map (above)

The Blast as I have Witnessed

On the afternoon 4 August 2020, the day was unlike any other day amidst severe COVID-19. At about 1755 in the afternoon, a small fire broke out in Warehouse 12 at the Port of Beirut, about 400 meters North to BNS BIJOY. Warehouse 12 was on the waterside and next to the grain silos; the warehouse stored the ammonium nitrate that had been confiscated from MV RHOSUS, alongside a "stash" of firecrackers. BNS BIJOY was on the opposite side of Silo. As commanding officer, I was informed that a small fire had broken out. Then and then, I decided to observe the fire by going to the scene of the fire by myself. Then I took a bicycle and went near the warehouse where the fire took place. After going there, I saw a few people, mostly from the fire brigade, struggling to control the fire and a few of them were witnessing and recording video with their mobile phones. Observing the unusual situation, I decided to leave the place instantly; and while returning with the bicycle, the intensity of the fire was getting increased. Just after a few seconds, when I was near about 50 yards from our ship BIJOY, the catastrophic blast took place. It rocked central Beirut and threw a red-orange cloud into the air, which was briefly surrounded by a white condensed cloud. The orange-red colour of the smoke was caused by nitrogen dioxide, a byproduct of ammonium nitrate decomposition. The explosion was felt in northern Israel and in Cyprus, 240 kilometers (150 miles) away. It is circulated that there were two explosions on that day from the fire, but as an eyewitness, there was only one explosion that destroyed everything. The so-called first explosion was the sound of increasing intensity of fire from the firecrackers inside the warehouse. This first explosion was heard locally, and the impact was limited to the warehouse only.



Figure 3 : Before and after the blast

The explosion destroyed everything in the port and the city nearby and brought almost everything to the ground. The catastrophe overturned cars and stripped steel-framed buildings of their cladding. It caused damage to the merchant ships berthed nearest to the warehouse. Within the port area, the explosion destroyed a section of shoreline and left a crater roughly 124 m (407 ft) in diameter and 4 to 6 m (13 to 20 ft) in depth. The grain silos were largely destroyed, exacerbating food shortages caused by the COVID-19 pandemic and a severe financial crisis. About 15,000 tons (14,800 long tons; 16,500 short tons) of grain were lost, leaving the country with less than a month's worth of grain in reserve. However, part of the

silos' sturdy structure survived and seemed to be shielding a large area behind it. But this shielding Silo could not save much because of the severe shockwave which traversed everywhere around the explosion. Because of being berthed about 400 meters on the opposite side of the silo, Bangladesh Navy Contingent Ship BNS BIJOY sustained severe damage - both material and personnel.



Figure 4 : Destruction of the devastating blast

Immediately after the blast, a local tsunami with a considerable wave height hit the ship at the jetty. The ship started going to and pro-parting its berthing hawser (heavy ropes). With the first wave, two ropes parted, and with the return wave, another rope parted. Lastly, the ship was on only one hawser parting which would bring real disaster to the ship sinking on the spot. I, being the only standing person on the jetty, could fasten the ship's rope to the bollard, which probably saved the ship from banging onto the jetty.

Human Losses

On that day morning, BNS BIJOY just berthed at Beirut Port Jetty after completing Maritime Interdiction Operations in AMO (Area of Maritime Operation) duty of UNIFIL in the Mediterranean Sea as its regular roaster. Generally, ships prepare for the next sea strip during their port stay and also pass leisure time for recreational activities. That afternoon, several crew members of BIJOY were on the upper deck, busy with their respective jobs, such as afternoon games, daily routine exercise, ship maintenance, etc. Suddenly, at about 17.55 hours the crew noticed a ball of smoke near the food grain silo. People paused their respective jobs to see the fire from a convenient place. It was not so imminent that fire could anyway be a danger to us and our ship. However, as mentioned above,

I went to investigate and evaluate the fire to take necessary action if needed. While I was coming back from the scene of the explosion with the bicycle, all of a sudden I found myself spinning in the air and fell on the concrete road. Though I got multiple injuries in the body, I can only remember that it was the end of my life. However, just after the explosion, everything calmed down for a while. I did not know that I had injuries, so I ran immediately to the ship to see what happened to the ship and its personnel. On reaching the ship's brow (ladder), I found people groaning and most of them were lying down like dead bodies. One was about to fall into the sea. He was severely injured on the head scull and shoulder. I could pull him back to safety. Altogether 36 personnel of BNS BIJOY sustained multiple injuries; most of them lost their hearing, and a few of them broke their hands or legs or got fractures.



Figure 5 : Glimpses of Human injuries

Two sentries of Lebanese armed forces were on guard at our ship's side, both were missing. Two days later, one dead body among the two could be recovered, and another could not yet be traced. There was one port immigration office where

four persons were on duty, and all of them died. The firefighters on the scene vanished nowhere, and even their dead bodies could not be recovered. Probably their bodies scattered into small parts or even dust. Besides some people of the port and many outsiders died who were the residents of the capital city nearby.

Material Damage

In addition to the suffering of 36 personnel injuries, the shockwave of the blast caused significant material damage to the upper deck, superstructure fittings and sensors outfit. The impact of the shock wave, huge blast sound, and flying objects from the explosion area caused grave material damage to the ship. The blow of the sound, flying objects and ripped-off material by shock waves caused numerous damages both inside and outside the ship. The material damage includes mostly structural damage to the ship, equipment damage, and damage to the doors and frames. Almost all the radar aerials broke down to decks. The air inlet valve, piping, air conditioning cooking facility doors and hatches, nothing were spared. Even the magazine door was deformed, and the possibility of ammunition danger popped up. As the ship was very strong and robust-built in UK, the hull of the ship would remain intact with minor deformities in one or two places, if the ship were of thin plate there could be a lot of human casualties and the ship could sink.



Figure 6: Damages onboard BNS BIJOY

Challenging Evacuation of Injured Personnel

Evacuation of the injured personnel was the hardest challenge in real-time. At first, it was required to muster all the personnel to determine the number of injured personnel by category of injuries. But there were rumors that the explosion was from the Israeli Air Force and there might be further attacks. As such, the mustering of the personnel could not be done easily because several ship companies left the ship in speculation of further attack. Finally, all personnel were mustered and found correct. Meanwhile, primary first aid had randomly been given to all by the ship's personnel. We tried to determine the state of the injuries, but we are in dismay with the severely injured ones. The challenges of evacuation are as follows :

a. Roads up to 10 kilometers (approximately) were blocked by the debris.

b. Most of the vehicles on the road were destroyed or incapacitated.

c. Nearby civil areas, including shops, restaurants and hospitals sustained damage.

d. Hospitals also suffered casualties.

e. All the people in the city were searching for their dear and near ones with whatever means they had at their disposal. As such, the evacuation of our ship personnel was at the stake. The Lebanese armed forces also suffered human casualties and severe destruction of their bases, equipment, resources, and materials.

f. The UNIFIL headquarters where injured personnel will be evacuated was away from the scene of the incident.

g. All sorts of communication were disrupted. However, when communication was restored, anyone from anywhere started calling Commanding Officer and other officers, which hampered the evacuation to some extent.

h. Rumour everywhere.

Under such a situation, we were desperately looking for evacuation at the mercy of the Almighty. No vehicles or ambulance support were available at the first instance. First aid, with available resources from the medic and non-medic team, was a great help initially. In the meantime, communication with local sources and UNIFIL HQ was established. By this time, some of the Lebanese armed forces vehicles with security personnel had arrived at the port premises. But they were busy with port security and the evacuation of Lebanese people. Seeing no sign of external assistance, I ran to one of the Lebanese Army vehicles for immediate assistance, but the driver declined to go unless approved by a senior officer present at the scene. Then I approached the officer who was in civil dress (I was also in civil dress), the officer did not say anything, nor did he decline. Taking his body language as approval, I told the driver to follow me up to the ship. So I ran to the ship and sent six severely injured personnel with two assistants and one doctor. So, by sending the first evacuation trip, I was a little bit relaxed, but to my surprise, around half an hour later, the doctor called me and said that due to the blocked road, they could not go up to any hospital. Then I suggested he proceed at any cost as that was an army assault-type vehicle. Finally, the vehicle could reach the nearest hospital, but the hospital lost a number of their staff sustaining a lot of personnel injuries and material damage. As such they declined to accept any injured personnel for treatment. Finally, they all returned to the ship, so we could not evacuate any personnel. Later, Major General Mujtahidur Rahman arrived with his vehicle and we used that vehicle to evacuate our three severely injured crews. The hospital did not accept all three injured personnel, but one was severely injured in the head. The hospital was full of civilian personnel. At night, assistance from UNIFIL headquarters started to arrive. Finally, we could evacuate all severely injured personnel to different hospitals by 4 a.m. transferring them in different phases. The Ambassador of the Bangladesh Embassy and his officials, the MTF ship Brazil's crew and the UNIFIL HQ team made a great effort to evacuate the injured personnel by their vehicles to local hospitals. We have been sincerely grateful to all of them.

Explosion Aftermath

UNIFIL Actions. After the explosion, UNIFIL HQ was very concerned for the affected MTF ship BNS BIJOY. They sent a medical evacuation team on the day of the explosion for emergency medical support and evacuation. MTF (Maritime Task Force) Commander assured me (as CONTICO- Contingent Commander) that UNIFIL would do anything possible to overcome the situation. However, we requested the MTF Commander for Helicopter support right in the port area for the immediate evacuation of severely wounded personnel and he agreed to send the helicopter. Accordingly, we also prepared the Helicopter landing site clearing foreign particles. Yet, possibly due to the rumors of further attack, the Helicopter never arrived. Later, the MTF commander ensured all injured personnel were placed in different UNIFIL-designated hospitals. He had sent a repair team to the BIJOY at the first instance for emergency repair and maintenance, though they could not contribute anything mentionable. HoM FC was also concerned for all the victims of our ship. The high officials of UNIFIL HQ took time-to-time feedback about the ship and injured personnel. The UNIFIL PIO (Public Information Officer) team came onboard the ship for media coverage. They featured a video on the official website after that the whole world came to know officially what happened to UNIFIL MTF ship BNS BIJOY during the explosion. Moreover, a damage assessment team came to the ship to ascertain the overall damage to the ship and the ship's company. They talked to all and examined the affected areas of the ship. The MTF commander and HoM/ FC visited the hospitals to see the injured patients and encouraged them to remain fit and sound.

HoM / FC Visit to BIJOY. The Head of Mission (HoM) and Force Commander (FC) of UNIFIL Major General Stefano Del Col visited BNS BIJOY with his team. He inspected the affected areas and met with minor-injured personnel. He addressed the whole ship's crew of BNS BIJOY and expressed his deepest concern and solidarity for the incident. He appreciated the patience and courage of the crew for fighting the situation professionally and courageously. He assured that he would always render all possible support to BNS BIJOY to overcome the situation as early as possible.



Figure 7 : Force Commander visiting Onboard BNS BIJOY
aftermath of the Beirut Blast

Bangladesh Navy Delegation Visit. A high-level four-member delegation from the Bangladesh Navy visited just a few days after the explosion. The delegation, headed by a Rear Admiral, along with the technical and operations teams arrived to evaluate the operational state and the extent of the damages caused by the explosion. Immediately after the arrival of the delegation, the Bangladesh Government sent a military aircraft C-130, with medical items, PPE (personal protective equipment), masks, medicine, and essential tools with aid to the Lebanese people that were handed over to the Lebanese Armed Forces at the airport. Moreover, the same aircraft brought a number of emergency repair and maintenance items for the repair of BNS BIJOY. The delegation visited the ship and various hospitals and met UNIFIL's Bangladeshi naval peacekeepers, particularly the injured personnel who sustained injuries due to the explosions. The delegation head addressed the whole crew and praised their effort to handle the situation. In addition, the delegation also visited UNIFIL Headquarters in Naqoura, where the delegation leader met with mission leadership for the immediate maintenance and assistance of BNS BIJOY and its contingent. Beside Bangladesh, many countries extended their hands for humanitarian assistance to affected people.



Figure 8 : Aid from Bangladesh Naval Delegation attending aid handover (left) and foreign troops deployed in the rescue operation (right).

Narratives from other Witnesses

The explosions caused heavy damage to our ship and injured more than one-third of the ship's crew. The peacekeepers who witnessed the devastating incident would never forget the day. One of the head-injured peacekeepers, Chief Engine Room Artificer Abdur Rashid, went on life-support for about two days and then became conscious. A few of the severely injured personnel got surgery and remained in the hospital for more than months. Some of them are still carrying the wounds in their bodies. Those who were on the upper deck and witnessed the first fire break out thought at first instance that it might be just a fire accident. According to several of them, they rushed to convenient places on the ship to see the fire. In the meantime, the intensity of the fire was increasing with a cracker sound. They thought something wrong but did not understand the mega incident might take place. With the increasing intensity of the fire, they panicked a little. A few of them clearly witnessed the mushroom of smoke during the blast. Those who witnessed the disaster would remember it for the rest of their lives. A few of them reacted as if they had forgotten what happened; they just could remember a huge blow and sound. Above all the incident of the Beirut port explosion is a very rare experience for all of those who witnessed it from the ship.

Docking of Ship

BNS BIJOY was scheduled to return to Bangladesh after completing the Tour of Duty (ToD) of the UNIFIL mission. The ship was performing its last phase duty and at the same time preparing for the return voyage after handing over the duty to the new Ship coming from home BNS SANGRAM, BANCON – 11. BNS BIJOY was supposed to return from the mission in July 2020, but due to a technical issue with the incoming ship, our return was delayed for about a month. Otherwise, the incoming ship SANGRAM was supposed to be in the harbor on the explosion day. Because of that explosion, our return from the mission was again uncertain. Just after the explosion, the chief of the Turkish Navy called chief of the Bangladesh Navy to convey their sympathy and offered repair, docking and maintenance of our ship at the Turkish naval base. Bangladesh Government accepted the gesture of friendship from Turkish. Turkish Navy towed the ship from Lebanon to Aksaz Naval Base, Turkish. Aksaz Naval Repair Command made all arrangements for the repair and maintenance of the ship. Finally, with the help of airlift equipment and rigorous maintenance and repair of our ship at the Turkish naval base, we could prepare the ship for the return voyage. BNS BIJOY again sailed back to Lebanon and took over the maritime interdiction duty of AMO. Thanks and gratitude to the Turkish Navy and all concerned for making the damaged ship operational.



Figure 9 : Turkish Navy Ocean Tug alongside BNS BIJOY

Lesson Learned

No lessons and no amount of precautions can protect us from incidents, accidents, and disasters, whether it is man-made or natural. However, still lessons can help us deal with the situation to save man and material to some extent. The Beirut port explosion on 04 August 2020 is marked as one of the most devastating accidental disasters in history. The disaster changed the day-to-day life of Beirut city in a fraction of a second and turned the city into a wreckage of disaster. Secured to a jetty very close to the disaster sight, Bangladesh Navy Ship BIJOY and its crew were severely affected by the explosion. As such, the experience of the disastrous explosion could be a great source of lessons for precautions, and if not prevented, at least handle any disaster of the same kind in the future. In that connotation, the followings are a few lessons for all of us :

a. **Trust on the Almighty**. Trust in the Almighty could ease the burden and sorrows. It would make people resilient and endowed with the strength and power to face any difficulties.

b. **Suppress Rumors**. Due to the rumors, ship's crew tried to flee away with their passports from the ship, which made the situation-tackling very difficult because it popped up the possibility that a few crew might be missing sustaining casualties. Immediately after any incident, command should disseminate their minds to clear doubts amongst their followers as far as possible.

c. **Avoid unnecessary communication**. After the incident, the commander should not be overloaded with unnecessary communication.

d. **Storing Chemical Items in Designated Areas**. Extra precautions may be taken to dump or store chemical ingredients or hazardous items. Particularly in port or heavy storage areas, items should be stored in designated areas only at all costs. Similar incidents were repeated in Bangladesh in Sitakunda, Dhaka and other areas.

e. **Fast Aid Training**. In addition to professional medical personnel, basic first aid training may be rendered to other non-medic personnel for immediate response.

f. **Firefighting Training**. A good awareness and knowledge of handling of firefighting equipment is a must.

g. **Unity and Morale**. Remaining united with high morale as a member of the armed forces would be a great key to fighting any disastrous situations, where trust in the Almighty would be a great source of inspiration.

h. **Voluntary Culture of Lebanese People**. The students of schools, colleges and universities in Lebanon voluntarily participated in cleaning the disaster-torn city from debris and obstruction. Along with the general population, they also established a relief center with tents where people brought whatever they had to the relief center and affected people took whatever they needed from the center without recording and registering. This cultural lesson may be inculcated among our future generations.

Conclusion

The Beirut Port explosion on 4th August marked one of the biggest accidental disasters in the world. The explosion was felt in Turkey, Syria, Israel, Palestine, and parts of Europe, and was heard in Cyprus, more than 250 km (160 mi) away. It was detected by the United States Geological Survey as a seismic event of magnitude 3.3 and is considered one of the most powerful non-nuclear explosions in history. The explosion played havoc across Beirut city and destroyed everything inside Beirut Port.

The explosions caused damage to Bangladesh Navy Ship BIJOY, the ship deployed in the UNIFIL mission was berthed within 400 meters of the explosion site and injured 36 Bangladesh Navy peacekeepers, with 23 of them requiring hospitalization. The explosion also caused material damage, including structural deformation, breakage of doors and hatches, damage to various electronic and electrical equipment and damage to navigational aids. Bangladesh Navy and UNIFIL authority were deeply concerned about the ship. Bangladesh Navy

Headquarters, LAF Navy and UNIFIL provided every possible support to the ship, but special support was provided by the Turkish Navy which repaired the ship thoroughly. Various contingents of UNIFIL did a tremendous job in the evacuation and hospitalization of injured personnel. The UN General Secretary had also expressed his deepest concern for the victims. The other international community and neighboring countries also expressed solidarity for the affected ship and injured personnel. UN also provided compensation to a few sailors for sustaining lifelong injuries, especially losing hearing ability.

The explosion did damage to the ship and injured so many personnel but it could not shake the morale of the crew. They fought against all odds and stood straight. All together, from the commanding officer to the sailors, handled the situation with the utmost courage and patience. The incident of the explosion will remain ever fresh as a bitter memory of all the crew onboard BNS BIJOY in real-time.

Biography of the Writer



Commodore Mohammad Joynal Abedin, (ND), NGP, ndc, afwc, psc, PhD, BN was commissioned in Executive Branch on 1st Jan 1993. During the passage of his service, he has served in number of BN ships and establishments including Bangladesh Coast Guard in various capacities. He has done number of courses at home and abroad. Few of the mentionable courses are Advance Turkish Language Course in Turkey, Navigation & Direction Specialization in India, Military Observer Course in Pakistan and Container Handling Course at Chattogram Port Authority.

Commodore Abedin obtained Master of Business Administration from Dhaka University as regular program conducted in MIST from 2002-2004. He also completed Master of Science in Military studies, Masters of Philosophy in Port Security and PhD on Marine Environmental Protection from BUP.

He is an alumnus of Mirpur Staff College, Armed Forces War Course and National Defence Course. He has commanded 08 ships of various types including 03 frigates and also served as Director of Naval Training at Naval Headquarters. Currently, he is serving as the Commanding Officer of BNS SHER-E-BANGLA

CORE MAINTENANCE ASPECTS OF BN – NEED TO KNOW FOR THE YOUNG OFFICERS OF BN

Commodore Md Mohidul Hasan, (E), OSP, psc, BN

Abstract

Repair and Maintenance are two different matters but almost always come together. In present day corporate world, the term Maintenance is defined and categorized in many ways/ types for better understanding and for selecting the optimum way of maintenance. As BN is operating a formidable size of fleet, it is very important for her to ensure proper maintenance for the ships and systems. With long experience, BN is now following a well-practiced way of maintenance which fits her considering various existing situations.

Introduction

As a navy officer we often come across the term "Repair and Maintenance". But, we seldom think why the two terms are often mentioned together. Again, as an engineer we very frequently engage with these two jobs. But, we seldom think about the differences between these two. Actually very few engineers probably think about it. Probably the reason behind this is that, both terms are so correlated and coexistent with the engineers, that they just do it without much thinking about the meaning of it.

In general by the term "Repair" we understand the restoration work when something or some equipment stops working, gets damaged or even gets broken. On the other hand, maintenance is routine activities aimed to prevent damage / breakdowns and extend the life of something or some equipment. So, generally we may think like that when "Maintenance" fails then "Repair" comes.

Whatever we generally understand, or whatever the dictionaries say, in present day world, especially in the corporate world, the term "Maintenance" is defined in many ways and also categorized in many types / sub-types for better understanding; and also for selecting the optimum way of maintenance for that particular organizations / industries. This term "maintenance" is not only applicable for industries or organizations where light to heavy machineries work, but also applicable even for a normal bureaucratic office or even for a home.

Since, Bangladesh Navy (BN) is operating so many ships, it is very important for her to ensure proper maintenance for the ships it selves, as well as the various machines, systems in various bases and ships. With 52 years of experience, BN is now following a well practiced way of maintenance which fits her considering various existing situations, environments, rules & regulations, demands, limitations etc. Concerned authorities are always trying hard for upgrading / adjusting this system of maintenance with the new demands. This not a research paper. Rather it targeted for the young officers of BN to educate them the broader aspects of maintenance activities of BN highlighting the core responsibilities, facilities and limitations. Considering the size limitation for the paper, it does not focus for the solutions to the problems; rather it actually provides fruits for thought to the targeted officers for thinking ahead.

Aim

To highlight the broader aspects of maintenance activities of BN to the junior / mid level officers emphasizing the core responsibilities of different offices / personnel, available facilities and limitations for thinking ahead.

Types of Maintenance

As already said, the term "Maintenance" is categorized in many types / sub-types for better understanding and selecting the optimum way of maintenance for that particular organization / industry. The types depend on the maintenance method, level of criticality, availability of time, cost involvement etc. The type will be different for each equipment / system. The following types of maintenance methods are commonly used in several industries[1] :

a. **Preventive Maintenance.** It is a method for preventing damage to equipment by periodically replacing parts based on time of use and carrying out minor maintenance and inspections to find out the current state of the equipment / machinery. Example: Cleaning, checking, lubricating, bolt tightening, periodic inspection, periodic & small over haul restorations.

b. **Predictive Maintenance.** Predictive maintenance is a method for doing maintenance by replacing parts based on predictions using a tool. The point is if the preventive method is only based on the schedule, then the predictive method is based on the results of the measurement. This method can also use the five senses, for example in bearing inspection can be distinguished from the sound produced. Or checking temperature, by touching it we can feel the difference or abnormality of the equipment.

c. **Corrective Maintenance.** It is a method intended to improve the reliability of equipment/machines by improvising. In addition to equipment, it is also intended for parts that have a short life cycle (to reduce the frequency of damage) and to reduce repair time. In other words, this method is to extend MTBF (Mean Time Between Failure) and accelerate MTTR (Mean Time To Repair) because of its reliability (activity to prevent recurrence of damage) and maintainability (activity to reduce repair time). Example: The operator has difficulty checking the oil volume of the generator engine, so improvisation is done by making a measuring cup equipped with a scale.

d. **Breakdown Maintenance.** It is a method where inspection and replacement of parts are not carried out, so with this method the equipment is left to be damaged and then that is fixed or replaced. Usually this method is applied to equipment / machines with following considerations :

(1) The equipment is optional (additional) equipment, and if it is damaged it does not interfere with production immediately.

(2) Cost of repair is less.

(3) Insignificant damage.

(4) Easy and fast repair.

According to some industries / agencies' thought and practices, there are two more major kinds of maintenance[2] :

a. **Risk-based maintenance.** Maintenance carried out by integrating analysis, measurement and periodic test activities to standard preventive maintenance. The gathered information is viewed in the context of the

environmental, operation and process condition of the equipment in the system. The aim is to perform the asset condition and risk assessment and define the appropriate maintenance program. All equipment displaying abnormal values is refurbished or replaced. In this way it is possible to extend the useful life and guarantee over time high levels of reliability, safety and efficiency of the plant.

b. **Condition-based maintenance.** Maintenance based on the equipment performance monitoring and the control of the corrective actions taken as a result. The real actual equipment condition is continuously assessed by the on-line detection of significant working device parameters and their automatic comparison with average values and performance. Maintenance is carried out when certain indicators give the signaling that the equipment is deteriorating and the failure probability is increasing. This strategy, in the long term, allows reducing drastically the costs associated with maintenance, thereby minimizing the occurrence of serious faults and optimizing the available economic resources management.

Total productive maintenance (TPM)[3]. Total productive maintenance is a maintenance activity that involves production operators in maintaining equipment / machinery in addition to activities carried out by maintenance operators. Examples are cleaning, lubricating, tightening nuts & bolts, daily checking (checking equipment / machine state), simple repairs (replacing leaking hoses, welding tips) etc. The objectives of the TPM are :

a. Develop operators that are able to detect damage signals as early as possible. Because it is the production operator that really knows the state of the equipment to even the most detailed part.

b. Creating a neat, clean workplace so that any irregularities can be detected as early as possible.

Maintenance Philosophy and Policy of RN

Maintenance Philosophy of RN. Due to the absence of Book of References (BRs) published by BN on most of the matters, generally various

BRs published by the UK Royal Navy (RN) are taken as BRs for BN also. Instructions regarding maintenance are found in the Chapter 5 of RN BR-3000- "Marine Engineering Manual". According to article 0501 of BR-3000, the Ship Maintenance Philosophy of RN (except for submarines – which is detailed in SMP23 of RN) is[4] "to ensure that HM ships may in time of war meet the heavy operational demands expected of them with the minimum of outside assistance, it is essential in peacetime for the material state of their hulls and equipment to be maintained in the best possible condition". The same article also mentions that, to achieve this, followings are to be done :

a. All Marine Engineering personnel are to be trained to carry out maintenance and repair work making best possible use of their capabilities and the resources available.

b. Peacetime programmes are to be planned to enable a balance between material and personnel maintenance and operational requirements to be achieved; such programming also serves as a guide in periods of tension and war.

c. Ship usage and upkeep plans are to give detailed information concerning Upkeep Periods, Fleet Time Support Periods and Self Maintenance Periods, including the frequency and general instructions for such periods.

d. MEOs are to be fully aware of the contents of the usage and upkeep plans applicable to their ships.

Maintenance Policy of RN. According to article 0502 of BR-3000, the MEO is to take every opportunity, both at sea and in harbour, to make progress with routine maintenance and to effect the repair of equipment and systems which are his material responsibility as defined in QRRN Chapter 10 and Chapter 1 of BR-3000. To enable the MEO to control and administer this task a Maintenance Management System (MMS) is sponsored and issued to the ship. Traditionally, the MMS will be derived from a combination of preventive and condition based maintenance items. In later classes the MMS has been compiled using Reliability Centred Maintenance techniques with the aim of maximizing equipment and system availability using optimal resources.

Types of Maintenance in RN. Maintenance Systems descriptions and instructions are given in BR 1313 – "Maintenance Management in Ships". In general terms there are three types of maintenance :

a. **Planned or Scheduled Preventive Maintenance.** Maintenance which is intended to pre-empt failure and is applicable to equipment which for operational, safety or legal reasons must be repaired on a calendar time or hours run basis or for which maintenance must match a specific event such as docking. A degree of over insurance is accepted. This type of maintenance regime is also used for equipment for which there is no suitable condition monitoring technique.

b. **Conditioned Based Preventive Maintenance.** Maintenance undertaken as a result of a measurable deterioration in the performance of equipment and for which maintenance does not have to be tied to a specific occasion. Specific information on condition monitoring techniques is given in the instructions in BR 6534 - Vibration and Condition Monitoring of Machinery in the Royal Navy.

c. **Corrective Maintenance.** Maintenance undertaken either as a result of or during defect repair. Whenever possible the MEO is to ensure that defects are made good as they are discovered (QRRN Chapter 10).

Mandatory and Starred Maintenance. Again, according to BR-3000 (article 0503), maintenance required items are categorized in two categories :

a. **Mandatory Items.** Maintenance items that will have a critical effect on safety or operational capability are marked as mandatory and must be completed when due as defined in the MMS. The MEO does not have authority to defer these items. If for operational or logistical reasons the MEO is unable to complete these items then he is to seek a concession from the appropriate authority. In extreme cases a programme change may be required to enable mandatory maintenance to be carried out.

b. **Starred Items.** Starred maintenance items are those for which undue postponement may affect the safety of personnel or result in damage to equipment

which will seriously degrade the ship's seagoing characteristics or fighting capability. The MEO does have the authority to defer starred maintenance items but is not allowed to delegate this responsibility. The MEO is to ensure that he is made aware of all items of starred maintenance that may need to be deferred before the due date and he must give very careful consideration to the implications of allowing the postponement of this maintenance.

Maintenance in BN

Instructions regarding maintenance in BN is found in the Chapter 3 of "Technical Reference Book" (published on 23 July 2020). It discusses and categorizes different aspects of maintenance. These are mostly in line with the aspects of RN but with slight modification to fit into BN environment /facilities. These are discussed very briefly in the following paragraphs[5].

Maintenance Policy and Types. Similar to RN, all ship's of BN will follow a definite Maintenance Management System (MMS) applicable for individual ship. The general MMS will be promulgated by FHQ/ Admin Authority after required endorsement from NHQ(DNE). In general terms there are three types of maintenance similar to RN :

a. Planned or Scheduled Preventive Maintenance.

b. Condition Monitoring Maintenance.

c. Corrective Maintenance.

Maintenance Levels. Maintenance Level will denote the group/organization that will carry out the maintenances. The following terminology will be used with regard to the organizational levels of maintenance of naval vessels and shore based operational equipment (this is not to be confused with the Depth of Maintenance):

a. First Line denotes ship's staff that is responsible for both the preparation for operation and the initial diagnosis of defects on the systems.

b. Second Line denotes the Fleet Maintenance Unit established to provide support for vessels and their systems for which facilities do not exist onboard the vessel to carry out repairs.

c. Third Line denotes the maintenance organizations within the Naval Service (Naval Dockyard, Workshops of Naval Stores Depots and Armament Depots) to provide support for vessels and their systems, excluding the organization within the First or Second Line. It implies workload for which no facilities or expertise exists within Second Line.

d. Fourth Line denotes private organizations (contractors) providing repair, modification and reconditioning/overhaul of vessels and their equipment for which the facilities, expertise or resources are not available within BN.

Maintenance Depths. Depth of Maintenance denotes the intensity of maintenance operation. The following terminology will be used in regard to the depth of maintenance and repair of naval vessels, machinery and equipment:

a. Depth A is that maintenance which is directly concerned with preparing the item for use, and keeping them in day-to-day order.

b. Depth B focuses on all maintenance and repair activities beyond those maintenance activities identified as Depth A and will normally not require specialised skills and support resources.

c. Depth C ensures that the item identified as faulty during Depth B maintenance is repaired and will normally require more advanced skills and support resources.

d. Depth D is full reconditioning, overhauling, major conversion, major rework, or such repair as involves work on this depth.

Other Major Points Regarding Maintenance. The Technical Reference Book discussed various other important points regarding maintenance. The book should be consulted by every officer and personnel whenever needed. However, some of the important points noted are listed below :

a. Mandatory and Starred Maintenance.

b. Upkeep, Update, Upgrade and Changes to Design.

c. Refit Periods and Types of Refit.

d. Supporting Units in the Navy.

e. Logistic Support Provided to Naval Ships.

(1) Naval Support to Ships on Deployment in Foreign Countries.

(2) Transportable Logistic Support (TLS).

(3) Logistic Support Ships.

f. Emergency Repair by Repair Authority.

g. Functional Tests of New, Repaired or Overhauled Machinery and Systems.

h. Restoration of Machinery Performance.

j. Restoration of Machinery Components to Standard Dimensions.

Basic Professional Responsibilities of Engineering Branch Offices / Officers

We have Engineering branch officers at various level of BN. In terms of repair hierarchy, the basic professional responsibilities of such three officers are given below :

a. **Ship[6].** As the professional Engineer Officer, he/she is to ensure that proper professional engineering standards and practices are adhered to in the upkeep and maintenance of engineering systems and equipment in his/her charge. He/she is to work closely with the other Heads of Department (e.g. XO, SO, LO etc.)

b. **DNE[7].** To ensure material support and to advise on all engineering matters.

c. **ACNS(M)[7].** To formulate policy in all matters concerning the material support of the fleet both ashore and afloat.

Repair Facilities

At present BN has the following repair facilities :

a. **BN Dockyard at Chattogram.** Under administrative authority of Commodore Superintendent BN Dockyard (CSD). It has got various workshops, sections and a small slipway to support the fleet with adequate manpower. Moreover it is supported by a floating dock (BNFD

SUNDARBAN) and a floating crane (BNFC BALABAN) both of which are under the administrative control of CSD.

b. **BN Dockyard at Mongla (Adhoc).** Under administrative authority of Commander Khulna Naval Area (COMKHUL). The TO&E of the dockyard is not yet approved. At present there is one appointed Superintendent (Commodore), one General Manager (Captain) under whom there are few officers, military staffs, civil staffs and some workshops with basic facilities. But, there is no docking facility at this moment. However, it's expansion plan is on going.

c. **Khulna Shipyard Ltd (KSY) Khulna.** This is owned by Ministry of Defence and commercially operated under BN management. It may be noted that, this is the only docking facility of BN ships in Khulna area. But it can dock only small size ships (upto length approx. 90m, draft approx. 3m, light displacement approx. 700 tons) due to various physical limitations (length of the carriage, limited depth of river adjacent to KSY and bridge over the river downstream to KSY).

d. **Dockyard and Engineering Works Ltd (DEW) Narayanganj.** This is owned by Ministry of Defence and commercially operated under BN management. This has also limited capacity mostly due to the carriage load capacity and limited depth of water adjacent to DEW.

e. **Chittagong Dry Dock Ltd (CDDL) Chattogram.** This is owned by Ministry of Industries and commercially operated under BN management. This is actually a support organization for the Chittagong Port. However, it has got a large graving dock which is at present the only means for docking large frigates of BN.

Logistics Facilities

BN uses the following logistics facilities for fleet maintenance :

a. **NSD Chattogram / NSSD Dhaka / NSD Khulna.** These Naval Store Depote / Sub-depotes are used for storing spare parts, equipments, tools, other maintenance items. They also store bulk items for ships' repair (like,

steel plates, pipes, etc.). They also procure items (upto a certain value) from local market as well as items needed urgently. In addition to these, they act as the "consignee" for BN procured items and perform shipping / custom formalities for imported items.

b. **All 5 Dock / Shipyards.** All major repair works are done by these dockyards / shipyards. For KSY, DEW and CDDL the repair works / docking / undocking etc. are done on commercial basis, and repair bills are paid from BN budget.

c. **Various Local Workshops / vendors.** These are used only when the concern dockyards are overloaded or some special support is needed.

d. **Supports from various OEMs.** These are used only when special support is needed from the OEM (Original Equipment Manufacturers) or from any SMEs (Subject Matter Expert), or the equipment is under warranty.

e. **Follow on Technical Support (FOTS) from US Navy, NAVSEA command.** This is a special arrangement / contract between the US Navy and BN. Under this contract USN provides technical support (including supply of spare parts / equipment) on payment for US supplied ships / equipments (like: spares, supplies, technical support for BNS SAMUDRA JOY).

f. **Eastern Refinery, Chattogram (through distributors).** For POL items.

Problem Areas

At present BN is maintaining a formidable fleet of approximately 70 ships. The types of ship varies from submarines to frigates to small auxiliary vessels. The origin ranges from western countries to South Korea to China and even Bangladesh. The variety in equipments are even greater. These create a real difficult job in terms of spare parts procurement and management. Apart from this, other major difficult areas in terms of maintenance is pointed below :

a. Non-availability of proper spare parts.

b. Non-availability of design, drawings and OEM's Instructions.

c. Difficulty of getting right manpower at right time.

d. Difficulty in arranging OEM Engineers / Technicians.

e. Non-availability of dedicated repair berth.

f. Difficulty of ensuring availability of ships due to frequent commitments.

g. Frequent requirements of unplanned maintenance (mostly for being an aged fleet).

h. Difficulty faced due to government procurement process.

j. New control systems and electronics.

Conclusion

For the fighting capability of the ships, the first two requirements are - "to float" and then, "to move". BN does not really have any written or well defined philosophy for maintenance. But, though it is not written, in practice / reality BN is following one well known philosophy for it – "To keep the ship fit for sea". Thus in our maintenance, keeping the ship ready for sea (ie. upto "to move") has always got priority. For long time keeping the ships' fighting capabilities intact was "important but somehow not fully achieved" as much as we needed. Now it is time to think about the whole system and put equal importance to the maintenance of all types of equipment and systems, so that the ships become really "Fit to Fight".

To achieve this shift in maintenance philosophy, we need to prepare ourselves gradually by changing attitude towards maintenance, improvement in logistics (including all types of logistics), proper training etc.

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Biography of the Writer



Commodore Md Mohidul Hasan, (E), OSP, psc, BN was commissioned in the Engineering Branch of BN on 01 Jul 1993. He is a graduate of BUET in Naval Architecture and Marine Engineering. He passed staff course from DSC&SC, Mirpur and obtained his MSc. from BUP. He attended various training courses at home and abroad. Among the training courses "Shipyard Management Course" from Pearl Harbor Naval Shipyard, USA; "Missile Airframe Engineering Course" from Naval Aeronautical Engineering Institute, China and "Marine Engineering Specialization Course: from BNS SHAHID MOAZZEM are most notable.

In his long carrier, he performed many staff and managerial duties. Some of the mentionable are Member (Engineering) of Chittagong Port Authority; GM at CDDL and KSY; various other appointments at KSY, DEW and BN Dockyard; Engineer Officer of various BN ships; Staff Officer at AFD and BCG Headquarters; Project Engineer Officer of two shipbuilding projects etc. At present he is serving as the Director of Naval Engineering at the NHQ.

THE EVOLUTION OF UNMANNED SURFACE VESSELS : CHARTING NEW WATERS

Commodore Md Monir Uddin Mollick, (TAS), NPP, ndc, psc, BN

Abstract

Unmanned Surface Vessels (USVs) also termed Sea Drones or Maritime Drones are autonomous or remotely operated watercraft designed to perform various tasks and missions without a human crew on board. USVs have emerged as a transformative technology with the potential to revolutionise various sectors including naval warfare. USVs are increasingly being integrated into naval warfare due to their versatility, cost-effectiveness and the capabilities they bring to modern maritime operations. Ukraine's deployment of USVs at a low cost heralds a new era in naval combat. Ukraine's sea drones have prevented Russia from gaining complete control of the Black Sea according to experts. Hence, many navies are intrigued by the success of the USVs and planning to integrate USVs into their fleet. USVs can be a valuable and cost-effective option for the Bangladesh Navy. These USVs can provide a range of capabilities and advantages that can help BN enhance its maritime security and operational effectiveness.

Introduction

Unmanned Surface Vessels (USVs) are autonomous or remotely operated watercraft designed to perform various tasks and missions without a human crew on board. These vessels are a part of the broader field of unmanned maritime systems and have gained significant importance in both military and civilian applications due to their versatility, cost-effectiveness, and safety benefits. In the vast expanse of the world's oceans, where human presence is limited and the challenges are immense, Unmanned Surface Vessels have emerged as a transformative technology with the potential to revolutionize various sectors. From enhancing maritime security to optimizing shipping operations and advancing scientific research, these autonomous, unmanned vehicles are changing the way we interact with the seas. Unmanned Surface Vessels are also termed as Sea Drones or Maritime Drones.



Unmanned Surface Vessels, Source : https://u24.gov.ua/navaldrones

The technology behind USVs or sea drones continues to advance rapidly. Modern USVs are equipped with sophisticated sensors, including sonar, magnetometers and cameras that capture high-quality images and videos. They are capable of navigating autonomously for extended periods and some are even designed to recharge their batteries through renewable energy sources like solar power. Machine learning and artificial intelligence are being integrated to enhance their ability to adapt to changing environments and make intelligent decisions during their missions. The recent deployment of Ukrainian Navy drones to attack Russian ships highlights the growing significance of unmanned surface vehicles in modern naval warfare. Multiple sea drone attacks carried out on Russian ships in Crimea and the Black Sea have grabbed recent headlines. These small drones have demonstrated their capability to limit the big force like the Russian Navy including their supply chain line. Hence, many navies are intrigued by the success of the USVs and planning to integrate USVs into their fleet. In this comprehensive article, we will delve deep into the world of USVs, exploring their history, current applications especially in naval warfare future potential and how they work. It will also highlight the impact of USVs in Russia-Ukrainian War and the opportunity for the Bangladesh Navy.

A Brief History of Unmanned Surface Vessels (USVs)

Unmanned Surface Vessels (USVs) represent a fascinating intersection of maritime technology and autonomous systems. They have a relatively short history compared to other maritime innovations, but their development has rapidly accelerated in recent years. Following is a brief history of USVs :

a. **Early Concepts (19th Century).** The concept of unmanned vessels can be traced back to the 19th century, with the use of remote-controlled torpedoes in naval warfare. These early prototypes were not true USVs but laid the groundwork for autonomous technology in maritime applications.

b. **Military Use (20th Century).** During World War I and World War II, remote-controlled boats and submersibles were developed for military purposes. These early attempts were often crude and lacked advanced technology, but they set the stage for further innovation.

c. **Evolution of Remote Control.** The late 20th century saw significant advancements in remote control technology. Military organizations began to experiment with semi-autonomous surface vessels, using them for surveillance and mine-hunting missions. These developments were an important precursor to fully autonomous USVs.

d. **Emergence of Autonomous USVs (Late 20th Century).** The late 20th century witnessed the emergence of truly autonomous USVs. These vessels were equipped with sensors, GPS, and rudimentary artificial intelligence to navigate and perform tasks independently. They were initially used for oceanographic research, environmental monitoring and hydrographic surveys.

e. **Commercial and Research Applications (2000s).** In the early 2000s, the commercial and research sectors began to adopt USVs more widely. They found applications in tasks such as marine research, oil and gas exploration and environmental monitoring. This period marked the transition from experimental technology to practical tools for various industries.

f. **Advances in Technology (2010s).** The 2010s brought significant advances in USV technology. These vessels became more sophisticated and capable of conducting complex missions in a variety of marine environments. Improved sensor technology, communication systems and artificial intelligence algorithms enabled more precise navigation and data collection.

g. **Growing Interest in Autonomy (2010s-Present).** The promise of autonomous USVs in maritime logistics, surveillance, and environmental

monitoring has led to increased interest from both private and government sectors. Companies and research institutions are investing heavily in USV development, leading to a proliferation of new and innovative designs.

h. **Integration with Other Technologies (Present).** USVs have been integrated with other emerging technologies such as drones and autonomous submarines. These integrated systems enable comprehensive oceanic exploration and surveillance by combining different types of unmanned vehicles.

j. **Diverse Applications (Present and Future).** Today, USVs are used for a wide range of applications, including offshore energy exploration, oceanography, search and rescue operations, military surveillance and maritime logistics. As technology continues to advance, their capabilities will expand, and they will play a crucial role in future maritime operations.

The history of USVs is a testament to the continual evolution of autonomous technology in the maritime sector and they are poised to become an integral part of future maritime operations, contributing to the safety, efficiency and environmental monitoring of oceans.

Use of Unmanned Surface Vessels in Naval Warfare

USVs are increasingly being integrated into naval warfare due to their versatility, cost-effectiveness and the capabilities they bring to modern maritime operations. Here are some of the key uses of USVs in naval warfare :

a. **Surveillance and Reconnaissance.** USVs are equipped with various sensors, such as radar, sonar, and cameras, enabling them to conduct extensive surveillance and reconnaissance missions. They can patrol coastlines, monitor maritime traffic and gather critical intelligence without risking human crews. In this role, they serve as the “eyes and ears” of naval forces.

b. **Mine Countermeasures.** USVs are employed for mine countermeasure operations, including mine hunting and neutralization. They can tow sonar

systems or employ autonomous underwater vehicles (AUVs) to detect and clear mines, ensuring safe passage for naval vessels in potentially mined areas.

c. **Anti-submarine warfare (ASW).** Some USVs are designed with specialized sonar and acoustic systems to detect and track submarines. They can augment traditional ASW efforts by continuously scanning for submerged threats.

d. **Anti-Ship Missions.** Armed USVs can carry various weapons systems, such as anti-ship missiles, torpedoes or small-calibre guns. They provide a platform to engage and neutralize enemy surface vessels, thereby enhancing a navy's offensive capabilities.

e. **Electronic Warfare (EW).** USVs can carry electronic warfare equipment to jam enemy communications, radar and navigation systems, disrupting an adversary's ability to coordinate and carry out naval operations.

f. **Coastal Defence and Force Protection.** USVs can serve as part of a naval task force, forming a protective screen around larger, more vulnerable ships. They can intercept threats, act as decoys and provide a defensive layer that mitigates risks to high-value assets.

g. **Swarm Tactics.** In certain scenarios, USVs can be deployed in swarms, operating collaboratively to overwhelm enemy defences and create confusion among adversaries. This tactic leverages the volume and coordination of multiple USVs to achieve mission success.

h. **Communication Relay.** USVs can act as communication relays, extending the range of naval communications and enabling connectivity in areas with limited infrastructure.

j. **Search and Rescue.** Beyond combat roles, USVs can be employed in search and rescue missions. They can locate and assist distressed vessels or individuals at sea, performing humanitarian tasks alongside military operations.

k. **Remote Operation and Autonomy.** USVs are often remotely operated, reducing the risk to onboard personnel. Some are also equipped with varying degrees of autonomy, allowing them to navigate and perform tasks with minimal human intervention. This autonomy enhances their operational flexibility and adaptability.

l. **Logistics and Resupply.** USVs can be used for logistical purposes, such as transporting supplies, ammunition or equipment between naval bases or ships, reducing the need for human-operated vessels in non-combat missions.

The use of USVs in naval warfare is continually evolving and their integration into naval fleets provides navies with a diverse set of tools for addressing a wide range of operational needs. As technology advances, their roles and capabilities are expected to expand further, making them an integral part of modern naval operations.

How USVs Work

USVs operate using a combination of technologies, including autonomous navigation systems, sensors, communication equipment and propulsion methods. The cost of USVs can vary significantly based on their size, capabilities and intended applications. Here's an overview of how USVs work :

a. **Autonomous Navigation Systems.** USVs are equipped with autonomous navigation systems that allow them to operate without human intervention. These systems rely on a combination of sensors, GPS, and onboard computers. Lidar, radar, sonar, and cameras are often used to help the USV detect obstacles, monitor its environment, and navigate effectively.

b. **Propulsion Systems.** USVs can have different propulsion methods, such as conventional propellers, water jets or electric thrusters. The choice of propulsion depends on the vessel's design and intended use. Electric propulsion is common in many USVs for its energy efficiency and low noise profile.

c. **Communication Systems.** USVs require robust communication systems for remote operation and data transfer. These systems enable operators to control the USV, receive telemetry data and transmit collected information in real time. Satellite, radio and cellular networks are typically used for communication.

d. **Sensors and Payloads.** USVs are equipped with various sensors and payloads, depending on their intended applications. These may include sonar for underwater mapping, cameras for visual inspection, weather stations for environmental monitoring, and more. The type and quality of sensors impact the USV's capabilities.

e. **Control and Autonomy.** USVs are typically controlled by an operator or autonomous control software. Autonomous control systems use data from sensors and GPS to make navigation decisions. They can follow pre-planned routes, avoid obstacles and respond to changing conditions. Operator control is often used for specific tasks that require human judgment.

f. **Data Processing.** USVs collect and process a wide range of data, which can include environmental data, images, videos and more. The onboard computers and software are responsible for processing and storing this information.

Cost of USVs

The cost of USVs can vary widely based on several factors :

a. **Size and Complexity.** Smaller, less complex USVs designed for basic tasks like environmental monitoring are generally less expensive. Larger and more complex USVs with advanced capabilities, such as military surveillance or offshore energy support, can be significantly more costly.

b. **Payload and Sensors.** The cost of sensors and specialized equipment can significantly influence the overall cost of a USV. High-quality sensors and advanced payloads add to the price.

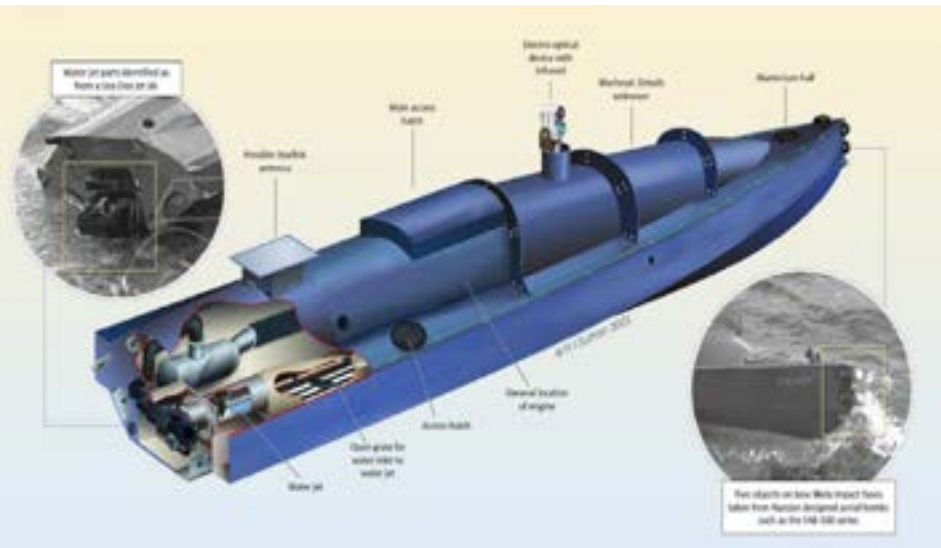
c. **Autonomy and Software.** Sophisticated autonomous navigation systems and control software contribute to the cost of a USV. More advanced autonomy features often result in a higher price.

d. **Customization.** Customized USVs designed to meet specific requirements can be more expensive than off-the-shelf models.

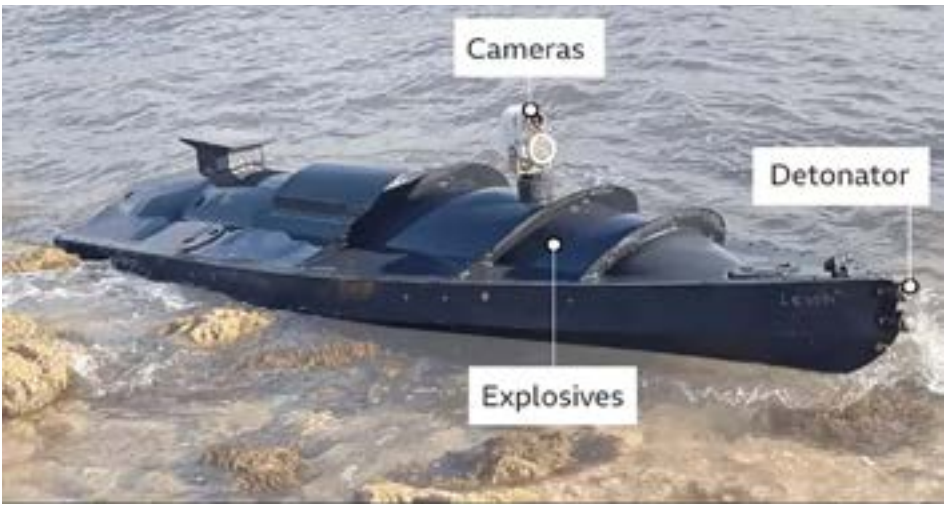
e. **Materials and Build Quality.** The choice of materials, build quality, and manufacturing processes also impact cost. Durable materials and high-quality construction can drive up the price.

f. **Operational Range.** USVs designed for long-distance missions may require additional features, such as more extensive communication and power systems, which can increase costs.

The cost of USVs could range from tens of thousands of dollars for smaller, basic models to several million dollars for larger, more advanced and mission-specific USVs. However, prices may have evolved due to advancements in technology and increased adoption.



Ukraine's USV used in Sevastopol Port Operation
Source : www.suttoon.com



Ukraine's USV, Source : www.bbc.com

Impact of USVs on Russia-Ukraine War

Ukraine's deployment of USVs at a low cost heralds a new era in naval combat. According to some commentators, the technique poses a growing risk to Russia. USVs are more difficult to spot on radar than navy warships since they move low on water and generate significantly less noise. While Ukraine does not have a large fleet, its sea drones have prevented Russia from gaining complete control of the Black Sea, according to Professor Katarzyna Zysk of the Norwegian Institute of Defence Studies.

The October 2022 attack on Russian naval facility in Sevastopol was the first in recorded history to deploy both marine and aircraft drones. According to GeoConfirmed, an organization that analyses satellite and other open-source images, the strike damaged at least three Russian ships. According to recent satellite photographs reviewed by BBC Verify, Russia has dramatically strengthened defences surrounding the site since then. According to Russia, three unmanned boats were involved in another attack on Sevastopol in September 2022 that injured 24 people. As reported by CNN the latest versions of USVs of Ukraine weigh up to 1,000 kilograms with an explosive payload of up to 300 kilograms, a range of 500 miles and a maximum speed of 50 mph.

Disadvantages of USVs

The field of view of onboard sensors may be limited, making it difficult to follow moving objects without precise position information or to identify ships that are disguised. Any problems with streaming video will put their mission in jeopardy because those equipped with onboard cameras also require regular connection with their controller in order to guide them to a target. But it seems like we're still in the experimentation phase rather than the revolution phase just yet. Nonetheless, Ukraine's plan has attracted worldwide attention and is encouraging other navies to create similar technologies and operating practices.

Unmanned vehicles must be tiny in order to be both feasible and inexpensive in large numbers. Because of their small size and low cost, they are very sluggish and/or have a short range. As a result, you'll need a way to rapidly transport and deploy huge numbers of drones to the battlefield. Cargo planes satisfy this requirement in the air. On the sea, a suitable large transport ship can do this.

Emerging Trends and Future Potentials

The future of maritime drones or USVs is brimming with potential. Artificial Intelligence (AI) is playing a significant role in making maritime drones smarter by enhancing their capabilities, autonomy and safety. Here's how AI is contributing to their intelligence :

a. **Autonomous Navigation.** AI-powered navigation systems enable maritime drones to autonomously plan and execute complex missions. Machine learning algorithms process data from various sensors, such as sonar and GPS, to help the drone make real-time decisions about path planning, obstacle avoidance and collision prevention. This ensures that the drone can navigate safely and efficiently in dynamic and often challenging maritime environments.

b. **Improved Data Processing.** Maritime drones generate vast amounts of data through their sensors, including sonar, cameras and environmental sensors. AI is used to process and analyse this data in real time, allowing USVs to identify and classify objects, map underwater terrain and detect

anomalies like shipwrecks or environmental changes. This data processing capability is invaluable for scientific research, environmental monitoring, and search and rescue operations.

c. **Target Detection and Tracking.** AI algorithms enable maritime drones to identify and track specific objects or targets of interest. For example, in applications like fisheries monitoring or anti-submarine warfare, AI can identify and follow specific vessels or marine life while filtering out irrelevant data. This targeted tracking enhances the efficiency and accuracy of these missions.

d. **Environmental Sensing and Monitoring.** AI-driven sensors on maritime drones can continuously monitor environmental conditions, including water temperature, salinity and the presence of pollutants or marine life. This data is essential for assessing the health of marine ecosystems, tracking climate change, and ensuring compliance with environmental regulations.

e. **Autonomous Decision-Making.** AI enables maritime drones to make autonomous decisions based on the data they collect. For instance, they can adapt their mission parameters, such as speed, depth or course, in response to changing environmental conditions. This adaptability ensures the safety and success of the mission while reducing the need for constant human intervention.

f. **Collaborative Swarms.** AI is also used to coordinate and control fleets of maritime drones in a swarm. These swarms can work together to cover larger areas, share data and perform more complex tasks like underwater mapping. AI algorithms ensure that drones in a swarm can communicate and collaborate effectively, making the operations more efficient and resilient.

g. **Improved Energy Efficiency.** AI can optimize the energy consumption of maritime drones by adjusting propulsion, navigation and data collection processes. By making drones more energy-efficient, AI extends their operating range and duration, making them more practical for long-duration missions and exploration in remote areas.

h. **Enhanced Safety and Security.** AI can help maritime drones detect and respond to potential security threats, such as unauthorized vessels, underwater mines, or potential hazards. This improves the safety of maritime operations and contributes to national security efforts.

In summary, AI is revolutionizing maritime drones by enhancing their autonomy, intelligence, and overall capabilities. These developments enable these vehicles to perform a wide range of tasks with greater efficiency, precision and safety, making them invaluable tools in marine exploration, research, industry and security.

Opportunity for Bangladesh Navy

Maritime drones or USVs can be a valuable and cost-effective option for smaller navies like the Bangladesh Navy (BN). These autonomous or remotely operated vehicles provide a range of capabilities and advantages that can help BN enhance its maritime security and operational effectiveness. Here are some key reasons why USVs can be a good option for BN :

a. **Cost-Efficiency.** Smaller navies often have limited budgets and resources. USVs can be a cost-effective solution compared to deploying and maintaining traditional manned vessels. They require fewer crew members, have lower operational and maintenance costs and can extend the operational lifespan of existing assets by reducing wear and tear.

b. **Persistent Surveillance.** USVs or maritime drones can conduct long-endurance surveillance missions over vast ocean areas. They can provide persistent monitoring of maritime borders, exclusive economic zones (EEZs) and high-risk areas, enabling smaller navies to detect, track and respond to potential threats, such as illegal fishing, piracy, smuggling or hostile incursions.

c. **Versatility.** USVs come in various forms, including surface drones, underwater drones and aerial drones that can operate over the water. This versatility allows smaller navies to tailor their capabilities to specific mission requirements, such as anti-submarine warfare, mine countermeasures, hydrographic surveys or search and rescue operations.

d. **Reduced Risk to Personnel.** By using maritime drones for missions like mine hunting or reconnaissance, smaller navies can reduce the risk to their personnel who would otherwise be exposed to potential danger. This also allows for more flexible and less risk-averse mission planning.

e. **Extended Reach.** USVs can extend the reach of smaller navies by allowing them to cover larger areas and respond to incidents at a greater distance from their bases. This is particularly valuable for countries with vast coastlines or maritime interests in distant waters.

f. **Force Multiplier.** USVs can serve as force multipliers by complementing existing naval assets. They can be used in conjunction with manned vessels and aircraft to enhance overall operational capabilities without the need for large naval fleets.

g. **Rapid Deployment.** USVs can be rapidly deployed, reducing response times to emerging threats or incidents. Their ability to be launched quickly in response to developing situations is especially valuable in critical scenarios.

h. **Covert Operations.** USVs can be employed for covert or clandestine operations, gathering intelligence or monitoring activities without drawing attention to a navy's assets. This is particularly useful in situations where discretion is required.

j. **Technology Advancements.** Advances in autonomous navigation, sensor technologies and communication systems have made maritime drones more capable and reliable. Smaller navies can leverage these technological developments to maintain a competitive edge.

While maritime drones offer numerous benefits to smaller navies like BN, their successful integration and operation require investments in training, maintenance and infrastructure. Additionally, international laws and regulations governing the use of these drones, especially in international waters, must be observed. Overall, USVs can significantly enhance the operational capabilities of BN and help it meet its maritime security objectives in a cost-effective manner.

Conclusion

The development of USVs continues to evolve, with ongoing advancements in technology and increased demand for their versatile capabilities. As a result, the range of available USV types is likely to expand addressing an ever-widening array of maritime and marine-related applications. The homemade drones, which are small, cheap, and difficult to defend against, have allowed Ukraine to open a new front in the war, attacking strategic military targets and symbols of Russia's dominance in the Black Sea, as well as the headquarters of Moscow's fleet in occupied Crimea and a bridge connecting the peninsula to the mainland. This innovative seaborne technology is gaining traction. According to experts, it has the potential to revolutionize the future of naval warfare. The real efficiency of maritime drones (USVs) used in the Russia-Ukraine naval conflict appears to be the product of a bigger trend in modern warfare, rather than a single instance of tactical success.

The maritime industry is standing on the cusp of a revolution and maritime drones are at the forefront of this transformation. As we navigate the complex waters of the 21st century, these USVs promise to be invaluable assets in safeguarding our seas, exploring the unknown and optimizing our maritime operations. However, their successful integration requires careful planning, ethical considerations and a commitment to overcoming the challenges that lie ahead. With innovation and responsible stewardship, USVs will undoubtedly chart new waters and lead us to a more sustainable and secure maritime future. Maritime drones or unmanned surface vehicles (USVs) might be a beneficial and cost-effective option for BN. USVs can provide a variety of capabilities and benefits that can assist BN in improving its maritime security and operational effectiveness in cost cost-benefit manner.

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Biography of the Writer



Commodore Md Monir Uddin Mollick, (TAS), NPP, ndc, psc, BN was commissioned in Bangladesh Navy on 01 January 1995. He did his basic training from the Royal Malaysian Navy. He has completed various courses both at home and abroad. During his career, he has served 41 PCS, Missile Boat Squadron, Mine Sweeper and Frigate in different capacities. Besides seafaring tenure onboard ships, he served as an Instructor TAS School, BNS ISSA KHAN, Staff Officer Operation, and OIC UN Cell in NHQ. He has commanded Four Launcher Missile Boat, 41 & 31 Patrol Craft Squadron. He has also commanded the Offshore Patrol Vessel and Corvette. He has also commanded two naval bases BNS Sheikh Mujib and BNS Shaheed Moazzzam. He did his peacekeeping duties at UNAMID Darfur, Sudan. At present, he is serving as Registrar of Bangabandhu Sheikh Mujibur Rahman Maritime University.

SMART CAREER DEVELOPMENT AND POST-RETIREMENT REHABILITATION FOR SAILORS IN BANGLADESH NAVY : CHARTING COURSES FOR THE FUTURE

Commodore M Nazmul Hassan, (N), NPP, BCGM, PCGMS, afwc, psc, BN

Abstract

*Career development is a vital component of sailor`s career planning and progression. Individual skill, motivation, and turnover issues remain critical concerns for the sailors of the Bangladesh Navy (BN). Focusing on such pertinent concept, BN warrants a holistic approach for smart career management encompassing training, employment, promotion, transfer, welfare and retirement strategies. Of late, the Chief of Naval Staff (CNS) has articulated his vision of transforming BN into a smart navy by 2030. To materialize goal-2 of his vision, the Drafting Authority (DA) has designed a comprehensive roadmap with five crucial agendas (05) and fifteen (15) associated actions that need to be materialized by 2030. The article is based on the various agendas and actions of DA that facilitate the development of a 'Smart Career' for BN sailors. The theoretical underpinning of smart Bangladesh vis-a-vis smart BN has been considered in suggesting a conceptual framework for 'Smart Career' development for BN sailors through a proposed '***3S - P***' model that encompasses Seniority (S), Super (S), Sea Service (S) and Punishment (P). It then focuses on pertinent issues like sustainable advancement and promotions based on merit and seniority, sanction-borne equilibrium amidst the career pyramid of BN sailors, sustainable turnover rate, revamping the course selection procedure, a hassle-free retirement plan, and office automation for the smooth delivery of services by DA. Finally, the paper discusses imperatives for BN in fostering 'Smart Career' development and post-retirement rehabilitation for sailors in the BN.*

Keywords : *Smart Navy, Seniority, Super, Sea Service, Professional Course, Smart Career, Promotion, Retirement and Rehabilitation.*

Introductory Background

In the era of Smart Navy, where cutting-edge technologies along with trained and efficient lean human resources, redefine naval warfare, the concept of 'Smart Career Development' for sailors becomes paramount in the BN. Dessler (2017) defines Human Resource Development (HRD) as the planned and systematic process of enabling employees to acquire skills, knowledge, and competencies required to meet current and future organizational needs. HRD remains the cornerstone of sailor`s career planning and progression. Employees who perceive the scope of opportunities for growth and advancement are more likely to remain productive and focused within an organization. Employee turnover remains a critical concern for organizations worldwide due to its impact on productivity, morale, and costs, and BN is no exception in this regard. Human Resource Management (HRM) interventions that focus on job satisfaction, organizational culture fit, and career development are instrumental in reducing turnover rates. The proper implementation of employee engagement contracts can significantly reduce turnover rates (Lee and Mitchell 1994). Focusing on such a pertinent concept for sailors, BN warrants a holistic approach to smart career development and management encompassing training, employment, promotion, transfer, and retirement strategies. Effective career development programs should be based on individual aspirations and the organization's needs (Sullivan and Arthur 2006). By addressing these issues, the 'Smart Career' development concept ensures that sailors are prepared to excel in their current roles and are well-equipped for combating the future challenges of the maritime sector of Bangladesh, in general, and BN in particular. Armstrong (2014) emphasizes the importance of striking balance between individual career aspirations and organizational needs. Through a comprehensive approach to smart career development, BN will continue to attract, retain, and empower a highly skilled and professional workforce commensurate with both the nation`s defense policy and human resource development. However the paper attempts to delineate a comprehensive work plan of DA designed with five(05) agendas and fifteen (15) actions amidst the goal-2 of the CNS vision document that need to be materialized by 2030, ensuring the professional growth, job satisfaction, and overall well-being of sailors throughout their career in the 'Smart Navy' and beyond.

Conceptual Underpinning of a Smart Navy for Bangladesh

Based on the vision of the Honorable Prime Minister to build a 'Smart Bangladesh' by the year 2041, the BN needs to revamp, grow, adapt, and sustain itself as a 'Smart Navy' by 2030, streamlining the growth of maritime potentials amidst national development goals. Therefore, the BN is committed to transforming into a modern and capable three-dimensional navy to safeguard sovereignty, protect maritime interests, uphold national and international responsibilities, and contribute to building a smart Bangladesh. Following Bangabandhu's dream of building a strong Navy, the CNS stated his vision as 'A Smart Navy for Smart Bangladesh' through the following five (05) goals :

Goal-1 : Focused Development of Operational Capabilities

Goal-2 : Creating and Managing Skilled & Motivated Human Resources

Goal-3 : Maintaining Robust Logistics & Maintenance Structure

Goal-4 : Sustained Welfare Initiatives

Goal-5 : Contributing to National Prosperity

To materialize the above-mentioned goals, BN's core guiding principles will be; firstly, the vision of the father of the nation, i.e., creating 'Sonar Bangla'; secondly, the spirit of liberation war of 1971, and finally, the directives of the government of Bangladesh. However, the trinity and associated elements of proposed 'Smart BN' are depicted below :

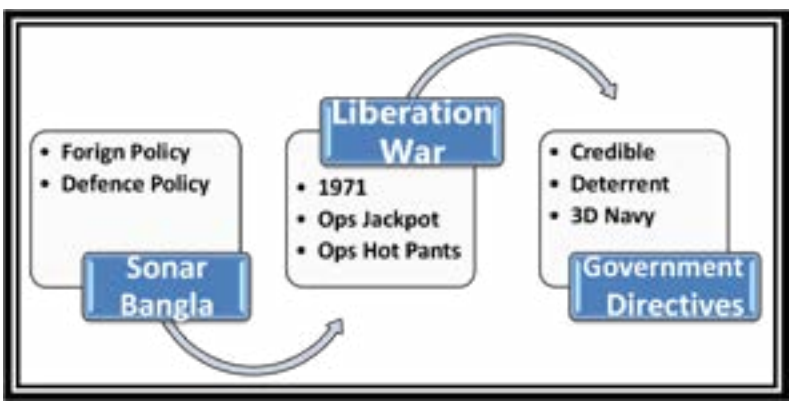


Figure-1 : The Trinity of Core Guiding Principles for Smart BN
(Source: Author's Construct)

Creating and Managing Skilled & Motivated Human Resources : The Agendas and Actions

Skill acquisition initiatives include training, education, and continuous learning opportunities (Jackson et al., 2014). In pursuit of creating and managing skilled and motivated human resources, the DA has identified the nurturing of smart sailors as the focal point of the goal number 2. Intrinsic motivation, derived from personal interest and satisfaction, fosters higher job performance and satisfaction (Deci and Ryan 2000). This necessitates the development and management of a skilled and motivated workforce that are essential elements for a robust and well-balanced three-dimensional navy.The enduring spirit of the liberation war of Bangladesh and a deep-rooted sense of patriotism will serve as the propelling force for the enlightened, motivated, and knowledge-driven sailors within the Bangladesh Navy. Future BN sailors are envisioned to possess professional, technological and technical expertise that commensurate with the requirements of both the 'Smart Citizen' and 'Smart Society' pillars seamlessly. As such, BN sailors' career planning tools and processes have to be dynamic in nature while tapping into the potentials of digitalization prowess.However, DA's five (05) agendas and fifteen (15) actions amidst goal-2 will be crucial for transforming BN into a smart navy and beyond by 2030. The prime moving ways and means of developing smart career for BN sailors will be synergized as under :



Figure-2 : Ways and Means of 'Smart Career' Development
(Source: Author's Construct)

Conceptual Framework of 'Smart Career'

The **'**Smart Career' development concept facilitates sailors in preparing themselves to excel in their current roles, equipping them to combat future challenges of the BN. The conceptual framework for 'Smart Career' development within the BN has been articulated in the '**3S - P**' model, representing a strategic approach to empower naval personnel in thriving excellence in career development. It focuses on individual's Service Seniority (**S**) including seniority achieved in their professional courses, Sea service (**S**), and highest efficiency assessment like Super (**S**), among other elements, of their career. Conversely, the model recognizes the adverse impact of Punishment (P) awarded to any sailor. However, sailors awarded with Punishment (**P**) due to mischief or misconduct will face challenges in smooth career progression. Elements like Seniority (**S**), Super (**S**) and Sea service (**S**) contribute positively, while Punishment (**P**) has got a negative impact on their smooth career development and progression. By balancing these elements, the '**3S - P**' model provides a comprehensive guide for sailors' career planning, ensuring a progressive trajectory. Therefore, the 'Smart Career' model, namely '**3S - P**', depicted below, will facilitate the smooth career development and progression of BN sailors :

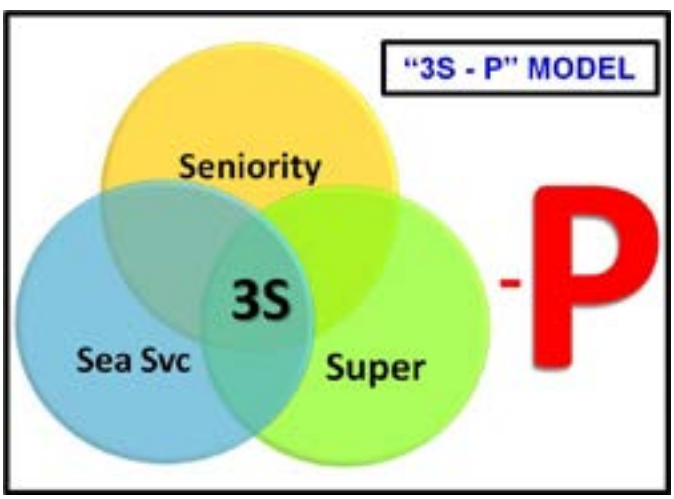


Figure-3 : 'Smart Career' Model (**'3S - P'**) for BN Sailors
(Source: Author's Construct)

The 'Smart Career' for BN Sailors

Career planning and development are vital components of human resource development. Formulation of a smart career plan is crucial for the effective employment of sailors to meet the operational requirements of the BN. DA needs to introduce seniority and merit-based promotion system that ensures the career progression of the most qualified sailors while maintaining sanction-borne equilibrium in the standard pyramid structure of BN. Additionally, sailors will receive regular counseling and informed decisions for developing his/her career in the BN. In this regard, DA`s actions will be as follows :

Back to Pyramid Structure : Sanction-borne equilibrium is a pre-requisite for smooth functioning of any organization, and BN is no exception. The current imbalance in the sanction and borne ratio across the twenty two (22) sub-branches underscores the necessity for realignment with the sanctioned pyramid structure of the BN. Such a mismatch can impede BN organizational effectiveness and hinder its capacity to meet operational objectives. Returning to the authorized pyramid structure is much desired for BN to maintain organizational harmony and efficiency. DA has taken the initiative to bring sanction-borne equilibrium back to the desired authorized pyramid structure by actively developing a comprehensive plan to ensure optimal organizational effectiveness.

Advancement and Promotion on Actual Vacancies : Advancement and promotion within the BN are meticulously planned, taking into account of the actual vacancies within specific sub-branches and ranks. There are six (06) ranks for advancement and promotion within the twenty two (22) sub-branches of BN, planned and executed as per the approved promotion policies and against actual vacancies. Such a sustainable approach ensures that career progression of BN sailors is systematic and commensurate with the operational needs amidst the authorized pyramid structure of the BN. By harmonizing promotions to actual vacancies, BN optimizes its human resources, contributing to a well-organized and efficient workforce that is responsive, dynamic and adaptable to changing operational demands.

Seniority and Merit-based Advancement : The integration of merit and seniority in the advancement and promotions system underscores the BN's commitment to fostering a workforce that is technically proficient, adaptable, and responsive to the dynamic changes of modern naval warfare. By prioritizing merit alongside seniority, the BN ensures a fair and effective career progression process that recognizes and rewards its capable sailors. The envisioned smart career plan recognizes the need for a seniority and merit-based promotion system that evaluates sailors' performance, skills, seniority and contributions to the BN, bringing qualified and proficient sailors into higher echelons. BN needs to introduce a seniority and merit-based promotion system that goes beyond traditional seniority considerations, ensuring that the most qualified sailors receive desired promotion among their peers. Smart and proficient sailors will be promoted based on their professional standing, physical fitness, and onboard performance. The seniority and merit-based approach will streamline the dynamic nature of BN operations amidst versatile and professional sailors.

Regular Counseling : Regular counseling sessions play a crucial role in shaping the career trajectories of BN sailors. Regular lectures by the DA are conducted across different naval areas to motivate and educate sailors on different policies, including importance of course seniority, sea service, super and the negative impact of punishment for smooth progression of their career. DA's lecture aims to motivate BN sailors with a deeper insight into professionalism amidst ethics and values that impact naval life and career progression. In addition to regular motivational lectures, 'DA's Support' software and BNDORS offices will also render tailor-made and personalized career counseling services to sailors based on their potentials and needs. Such efforts by DA on regular counseling, through traditional lectures, advanced software platforms and BNDORS offices, foster best practices in human resource development and career management. Thus, the sailors will receive necessary guideline and informed decisions for developing his/her career in the BN.

Sustainable Turnover Rate

Job satisfaction, organizational commitment, and perceived job alternatives significantly influence turnover intentions (Allen, Bryant, and Vardaman 2010). High turnover rate due to frequent transfer of sailors in different areas of BN has got negative impact on sailor and his/her family`s morale. It takes toll on sailors' personal budgets and disturbs family members regarding accommodation and offspring's education issues. Innovative HRM interventions that incorporate employee engagement strategies are gaining importance in reducing turnover rates. DA is actively working to formulate sustainable yet transparent transfer policies, considering sailors' preferences, family needs, and career aspirations. These policies aim to ensure individual preferences and family circumstances amidst smooth transition of sailors between different naval bases, ships and ISO organizations. By considering the preferences and needs of naval personnel, these policies can contribute to improved morale, increased efficiency, and reduced government expenditure associated with turnover, thus creating a more resilient, motivated, and contented workforce. As such, DA`s actions in this regard will be as under :

Sustainable Draft Policy for Sailors : The implementation of a sustainable draft policy that aims to strike a balance between the operational needs of the navy and the welfare of its sailors will foster a reduced turnover rate to optimize human resources. This envisioned policy aims to ensure that sailors are drafted according to a sustainable plan, allowing them to serve in a particular area for a maximum, specified period, typically three (03), four (04), or five (05) years, depending on their ranks and qualifications amidst the service requirement. Under the sustainable draft policy, sailors will be drafted to various naval areas basing on their preferences, expertise, skills, and the operational requirements of the BN. To facilitate such a policy, DA aims to issue a general draft preferably once a year by the year 2026 so that sailors` preferences for posting areas are considered amidst the service requirement. Thus the sustainable draft policy will improve the morale and job satisfaction of BN sailors, transforming them into a resilient and motivated workforce.

Balance between Draft for Courses, Zone and ISO services : BN sailors are drafted based on the specific demand for various professional courses, zone services, and Inter Service Organizations' (ISO) requirements. Potential candidates for training will be determined meticulously and drafted temporarily to various BN schools located at different naval areas to avoid a second-time draft within a year. Besides, zone services and ISO services for the sailors will also be planned sustainably so that turnover rate reduces to its minimum. Thus, striking a balance between draft for courses, zone and ISO services will foster creating a more effective operational environment with reduced turnover rates of BN sailors.

Revamping Course Selection Procedure

The current scenario of course selection within the BN warrants a comprehensive revamping of the existing procedure. Presently, the ratio of all-round qualified sailors in most sub-branches significantly outweighs the number of available promotion vacancies in respective sub-branches, presenting a substantial disparity. Current ratio of all-round qualified sailors in most of the sub-branches is approximately six (06) to seven (07) times higher than the number of promotion vacancies therein. This incongruence demands a meticulous audit and assessment of the training needs within the navy, particularly given the dynamic nature of technological growth in the BN. As such, the number of sailors for professional training need to be determined based on the corresponding promotion vacancies available in those particular sub-branches amidst the number of existing all-round qualified sailors therein. Hence, DA`s actions will be as follows :

Merit and Seniority based Course Selection Procedure : The DA is currently in the process of updating its course selection policy to adopt smart career plan for its sailors. It aims to ensure that the most deserving and experienced sailors are selected for their next professional courses. Meritorious and senior sailors will get priority in selection procedure of their next professional courses. The updated course selection policy, combining merit and seniority-based considerations, will foster better human resource

development for BN. Such approach of fostering principles of meritocracy and experience not only enhances the professional growth of individual sailors but also contributes to the overall development and effectiveness of the smart BN.

Sustainable vacancies for Course amidst Promotion Vacancies : The numbers of vacancies for various professional courses of BN sailors are not sustainable at present. Hence, DA is actively pursuing a sustainable plan of creating vacancies for professional courses with promotion opportunities for its sailors, fostering equilibrium in the BN career pyramid structure. The ratio between number of course participants and promotion vacancies will be maintained sustainably according to the BN career pyramid structure. The preferable number of course vacancies will be systematically managed to avoid excessive disparities of qualified sailors. It will not be more than one and a half (1.5) times higher than that of the vacancies sanctioned for the next higher rank according to the authorized career pyramid structure of BN. By maintaining such sustainable ratio, DA will be able to optimize its human resources by allowing for the professional growth of sailors amidst its functional hierarchical structure.

Retirement and Rehabilitation

Effective retirement planning and post-retirement support are instrumental in shaping a smart and comprehensive career development framework for sailors in the BN. DA planed a hassle-free retirement plan ensuring a smooth transition for sailors from naval service to civilian life. The retiring sailors need to be offered pre-retirement seminars to prepare themselves for post-naval life financial management, housing, healthcare options and employment opportunities. The development of a smart and hassle-free retirement plan underscores the BN's commitment to the holistic well-being of its sailors throughout their career trajectory. Hence, DA`s actions in this regard will be as under :

Smooth Retirement Process and FPEA Solutions : Offering flexible retirement options can positively impact employee retention, knowledge transfer and productivity (Topa et al. 2018). DA has taken significant steps

to streamline and simplify the retirement formalities for its sailors, making the process much more convenient, efficient and smooth. Furthermore, organizations can benefit from creating a positive retirement climate that promotes well-being (Wang and Shi, 2014). The sailors` retirement process has already been made easier and reduced to seven (07) days from sixty (60) days. Therefore, BN is getting expert services of LPR going sailors for an extra fifty three (53) days, enhancing BN operational capabilities. However, automation of the retirement system, which aims to further expedite the formalities and eliminate unnecessary hassles, is under process. Additionally, the BN is working on implementing a new policy regarding the return of public clothing, which will further make the retirement formalities for BN sailors much easier and convenient.Besides, DA has promulgated a new F.O. that is specifically tailored for retired sailors transitioning into civilian life smoothly. Sailors having inaccuracies or discrepancies in their family particulars have been granted opportunities to get it corrected until 31 July 2024. Furthermore, the DA has devised a comprehensive governance plan with specified timeframe and associated pragmatic strategies to address and resolve the longstanding FPEA issues of BN sailors for once and for all by 2025. The BN is committed to providing its sailors with the support they need to transition smoothly into civilian life and ensuring that their retirement is a seamless and hassle-free process.

Rehabilitation Training, Certification and Annual Job-Fair : Rehabilitation training for the retiring sailors will be arranged in various maritime training institutes with an objective to enhance their employability in diverse sectors. For instance, appropriate equivalent training and certification will be arranged for steward, cook and topaz branch sailors under Bangladesh Parjatan Corporation so that they can be employed in various hotels and restaurants after their retirement from BN. Besides, an annual job fair has been envisioned and tailored specifically for retired sailors from all branches. A holistic approach combining rehabilitation training, certification, and an annual job fair would foster the post-naval life transition of retiring sailors smoothly. Such an initiative by DA will connect

the retiring sailors of different sub-branches with renowned employers from different government and private companies. However, the maiden BN Job-fair has been planned and expected to take place by 2024 in the presence of renowned employers of different government and private companies fostering a direct link between retiring personnel and potential employers.

Veteran Networks and Support Services : All the retired BN sailors may be connected through social media or other online networks by BNDORS and thus be brought under a common platform for information sharing, mentorship, and potential employment support. DA should develop comprehensive transition assistance programs like career counseling and job placement assistance to support sailors as they transit into civil life. DA needs to collaborate with government agencies and private organizations to provide employment opportunities and networking facilities tailored to the unique needs of retired sailors amidst their naval qualifications and certification. This will help other government and civil organizations to recognize duly and honor the valuable skills and experiences gained by BN sailors during their naval career. Counseling support and financial assistance like loan may also be granted to the interested entrepreneur retired sailors in starting their own smart technology-related businesses, encouraging innovation and self-reliance.

Office Automation in DA

Automation reduces the likelihood of manual errors and provides a clear audit trail for decision-making processes. Human resource departments are now leveraging technology to offer personalized career planning resources (Inkson et al., 2012). Office automation is a crucial aspect of modernizing the BN administration. Recognizing the need for increased transparency, productivity and efficiency, the DA envisioned adopting automation through tailored-made software solutions across various spheres within its offices. These software applications can be designed to streamline various administrative processes, reducing manual effort and minimizing the risk of errors. A dedicated communication platform can facilitate seamless information sharing, task assignment, and progress tracking.

As such, DA should develop different software below to increase its productivity through regular office automation :

The BNSIS and Promulgation of "DA's Support" software : The enhancement of the Bangladesh Navy Sailor Information System (BNSIS) is the cornerstone of naval personnel management focusing efficient data management of BN sailors. It always remains under up-gradation process wherein sailors`data are updated and preserved in the server for their career management and development. On the other hand, the introduction of the "DA's Support" software represents pivotal steps in advancing real-time interactive communication with the DA regarding BN sailors` career management and development. Presently, "DA's Support" software development is under process. Once implemented, this software will provide a direct and interactive communication for administrative authorities, commanding officers, directors of NHQ and BCG Headquarters, and other concerned officers in seeking advice from the DA. The software user will be able to communicate with DA quickly for all kinds of advice against their queries related to sailor`s professional courses, transfers, promotions and other administrative issues. The upgraded BNSIS and the forthcoming "DA's Support" software contribute synergistically to the modernization of naval administrative processes. These technological initiatives in personnel management contribute to the overarching goal of modernizing BN into a smart Navy.

Genform Automation and Up-gradation of F(SP) Forms : The up-gradation of the F (SP) Forms and the implementation of Genform automation within the BN signify optimization of administrative processes and embracing digital transformation. Currently, all significant events in the career and administrative issues of BN sailors are formally documented through the paper written Genform and forwarded officially to DA. The information of Genform is then cross cheeked manually by DA and the data are inserted into the BNSIS to transform them into digital records. This entails the development and implementation of automated Genform templates that insert sailors' data directly to the BNSIS and thus saving man-hours. As

such, Genform automation is under process wherein automated Genform may be used in the BNSIS software after being verified by DA. Besides, Sailor's engagement, recommendation, promotion etc. are forwarded through different F(SP) forms that need to be revamped and up-dated since a few F(SP) forms become outdated and warrant due up-gradation. However, up-gradation tasks of different F (SP) forms have been already undertaken by DA.

User friendly DAO and BOE Procedure : The Jasthota Padak and Sea Service Pin for BN sailors recognize specific years of distinguished naval services and sea service respectively. The recent and maiden promulgation of special DAOs related to Jasthota Padak, Peace time medal and Sea Service Pin for BN sailors underscores the commitment of the DA in making these DAOs user-friendly. The current Board of Enquiry (BOE) procedure within the BN has been identified as time-consuming and complex affair. To address this issue and streamline administrative processes, concerted efforts are underway to develop a more user-friendly BOE procedure. The aim is to simplify the process, making it more efficient and reducing the associated man-hours required for its completion. However, DA is working relentlessly to devise further user-friendly DAO and BOE procedure.

Concluding Remarks

Investing in HRD can lead to improved employee performance, job satisfaction, and retention rates (Noe et al., 2019). The implementation of a Smart Career Development Framework for BN sailors is not only an agenda of the era; it is too a strategic imperative in tapping the potentials of retired BN sailors into the maritime human resource development of Bangladesh. Organizations can boost motivation through various means, such as providing meaningful work, recognition, and opportunities for personal and professional growth (Pink, 2009). By focusing in comprehensive training system, merit and seniority based promotion policy, efficient employment and smooth retirement transitions policy for sailors, the BN will cultivate a highly skilled, professional, pragmatic, and motivated workforce for the nation. Through this holistic approach to Smart

Career Development not only benefits individual sailor but also strengthens the overall capabilities and effectiveness of BN in safeguarding the nation as a whole. By investing in comprehensive training, sustainable promotion practices and appropriate job placements, reduced turnover rate, dignified retirements, and office automation, the BN sailors will foster a sense of loyalty, dedication, and pride among themselves which will facilitate the vision of smart navy come into reality. In conclusion, the above mentioned agendas and associated actions not only will empower BN sailors to excel in the desired smart navy but also will facilitate in preparing its sailors for successful transitions beyond their naval service in the digital era, ensuring a legacy of professional excellence and productivity in the maritime domain of Bangladesh.

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Biography of the Writer



Commodore M Nazmul Hassan, (N), NPP, BCGM, PCGMS, afwc, psc, BN joined Bangladesh Naval Academy in 1992 and was commissioned in the Executive Branch of Bangladesh Navy (BN) in 1995. Over the span of 29 years in his naval career, the officer he held diverse roles aboard numerous BN ships, ranging from patrol craft to Missile Frigate, demonstrating versatile capabilities. He commanded Patrol Craft, Mine Sweeper, Large Patrol Craft, Offshore Patrol Vessel (OPV), and a significant Base of BN. Notably, he commanded the largest OPV of the Bangladesh Coast Guard (BCG), equipped with marine pollution control capabilities. Additionally, he served as the Squadron Commander of the OPV Squadron, Deputy Commandant of the largest training base and as Director of IT & Communications of the BCG Headquarters. The officer previously served as a Section Commander to the Drafting Authority at the Naval Headquarters and led a Military Observer Team Site in the DR CONGO under the United Nations. Furthermore, Commodore Nazmul, during his mid-career, contributed to vital security endeavors such as, a GSO-2 at the Headquarters of DGFI and, a Deputy Director of the SSF of the Prime Minister's Office. His academic achievements include graduation from the Defence Service Command and Staff College and the National Defence College, both in Mirpur, Dhaka. He also earned a Master of Public Affairs degree with distinction from the University of Dhaka, a Post Graduate Diploma in Human Resource Management from BIMS, and an MSc degree in Military Studies from the Bangladesh University of Professionals (BUP). His international exposure includes alumni status at the DKI Asia Pacific Centre for Security Studies, USA, and the Asia Pacific Centre for Military Law, Australia. He has number of professional journals published in his credit. His exceptional courage and contributions in peacetime operations earned him prestigious accolades, including the Nou Parodoshita Padak (NPP) in the BN and the Bangladesh Coast Guard Medal (BCGM) – the highest gallantry award for peacetime operations in the BCG, along with the President Coast Guard Medal Seba (PCGMS). The Officer was married to Dr. Sonia and blessed with three daughters. Currently, Commodore Nazmul serves as the Drafting Authority of the Bangladesh Navy and pursues a PhD in Marine Protected Area Governance at the Bangladesh University of Professionals. The author can be reached at nazmul1004@gmail.com.

STRATEGY IS AN ART, NOT A SCIENCE

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Abstract

Strategy is an 'art' or 'science' is long standing debate since 15th century amongst many academics and military strategists which continues till date. The strategists are divided with the subjective knowledge of 'art' and the objective knowledge of 'science' of the strategy. The debate has further loudened as a 'science' due to the calculative but debatable methods of end, ways and means; technological advancement on nuclear, cyber, space, artificial intelligence etc challenging the strategy as an art. This study discussed the controversial issue of whether strategy is an art or science or both and examines the claim in support of 'strategy as art' under the overall circumstances of the subjective knowledge of art and objective knowledge of science. The outcome of the arguments highlighted in this article finds that the art of using evolving technology under the dynamic condition of war is the strategy. The existence of 'strategy as science' may or may not be there, but the existence of strategy as an "art" will always be there.

Introduction

The idea of the conduct of war and conceptualizing strategy as "science" or "art" has always been a disputed issue among military strategists. Many academics and strategists have put their efforts to prove strategy as a "science," while others have argued it to be an "art." In fact, "it combines the 'objective knowledge of science' (insofar as it can be objective) with the 'subjective knowledge (or skill)' associated with art." [1] This debate started in the 15th century and continues till date. Strategists, those who agreed with the objective nature of science and technology, also believe that everything relevant to the conduct of war can be formulated under some universal system and mathematical calculations. It is the science that determines the application of resources and ensures the ultimate outcome of the war. On the contrary, strategists who believe in subjective knowledge (or skill) or intangible qualities feel that objective knowledge or science and technology will

1. Antulio J Echevarria, II, Military Strategy: A Very Short Introduction (New York: Oxford University Press, 2017), 35.

always be there, which does not reflect the fundamental nature of strategy. Rather it is the general's wisdom, insight, intuition, and creativity that synchronize with the dynamic character of war and determine the strategy.

Thus, this paper raises the controversial issue of whether strategy is an art or science. Indisputably, the systematic approach to science with "ends-ways-means" is also logical and relevant. Nevertheless, remaining within the unpredictable everchanging scientific clime and finding the appropriate way with knowledge, experience, wisdom, and vision; are the fundamental nature and artistic character of strategy.

Under the above circumstances, this paper argues that strategists who believe that strategy is a science have been proven wrong in the circumstances of the uncertain nature of war and subjective knowledge (or skill) of the leader—that makes it an art. To establish that argument, this paper analyzes the historical findings and finds out the reason for its classification as science or art. This paper also analyzes the principal arguments in favor of science and puts counterarguments accordingly. It is important to note that strategists' views on science do not necessarily cross out opposite arguments, as others may have different views. Finally, this paper highlights and examines the claim in support of 'strategy as art' under the overall circumstances of the subjective knowledge of art and objective knowledge of science.

The history of the use of the term "science" or "art" for the conduct of war (later termed as a strategy) can be traced back to 1466 when "Jean de Bueil in his Jouvencel, told his readers that 'the conduct of war [should be] artful and subtle, which is why it is appropriate to conduct it by art and science".[2] Reasons for describing the conduct of war as "art" are known to be the characteristics of uncertainty, chaos, unpredictability, irrationality and psychological aspects of warfare.[3] On the contrary, the Newtonian revolution in 16th century brought about a notion that every aspect of warfare can be formulated into

2. Beatrice, Heyser, "Theory and Practice, Art and Science in Warfare: An Etymological Note" in War, Strategy and History: essay in Honour of Professor Robert O'Neill, eds. By Daniel, Marston and Tamara Leahy, (Canberra, ANU Press, 2016), 180

3. Vego, Milan. 2012. "Science vs. the Art of War." Joint Forces Quarterly, 3rd Quarter: 62-70, 66

mathematical theories.[4] This revolution increased the application of science in the conduct of warfare. Such scientific applications are "calculation of firing distances and the targeting of cannon",[5] "supply line and distances of depot",[6] "zigzagging trenches"[7], "reducing the experience to understand war[8]" and "set rules and principles to conduct war[9]" further strengthened the debate towards science. Moreover, mathematical theory of finding victory in war such as, "F.W. Lanchester devised the so-called N-square law",[10] deeply inclined the conduct of war into 'science'. However, it could only define theory in ideal conditions and the war remained in its obscure form embraced with uncertainty. Nevertheless, such historical efforts and inventions have lifted up the argument to the highest academic level and denote that the explanation of the conduct of war or the strategy as "art" and "science" is correct in their respective way.

Continuation to the invention of military theories, today, the Lukke Model of military strategy[11], which was formed by Colonel Arthur F. Lykke Jr. has provided an easy and systematic understanding of "Strategy equals ends (objectives toward which one strives) plus ways (courses of action) plus means (instruments by which some end can be achieved)". This mathematical method is widely accepted in US defence community and provides an easy and short-cut understanding of the strategy. It is one of the major examples for the argument that prove that there is a systematic way of finding the strategy. On the contrary, this model has undermined the "creative and effective strategic thinking" and introduced a new problem of an ends-means mismatch by neutralizing the requirement of ways[12]. In this formula, all problems will be solved by a whole-of-government

4. Ibid, 62
5. Heyser, "Theory and Practice, Art and Science in Warfare: An Etymological Note", 183
6. Ibid 184
7. Milan, "Science vs. the Art of War", 62
8. Ibid 65
9. Ibid
10. Lanchester, F. W. 1995. Aircraft in Warfare: the dawn of the forth arm (Rev ed.). Sunnyvale: Lanchester Press.
11. Arthur F Lukke. "Toward an Understanding of Military Strategy." In U.S. Army College Guide to Strategy, by International Security and Counter Terroroim Reference Center, 179-185. (US Army College Press, 2001)
12. Meiser, Jeffery W. 2016. "Are our Strategic Model Dlawd? Ends+ Ways + Means + (Bad) Strategy." The US Army College Quarterly: Parameters Winter 46 (4), 82

approach with all the elements of national power[13]. As there is no 'way', the strategy is "reduced to a perfunctory exercise in allocating resources".[14] This has also undermined the fundamental question of the strategy of "why and how"? In essence, this formulaic approach cannot provide the appropriate solution or a good strategy. It can only provide a statical solution in an "ideal circumstance"[15] which may define the fundamental nature of the strategy.

Figures 1 and 2 below show the balanced relations between means, ways and objectives, and the importance of subjective knowledge (or skill) or art. Figure 1 shows that Nation A with a small number of resources and technology may maintain its objective while utilizing 'subjective knowledge' such as wisdom, intuition, vision, morale, experience, passion, mental soundness, creativity etc. One of the examples of such a condition is observed during the US-Vietnam war 1965-73.

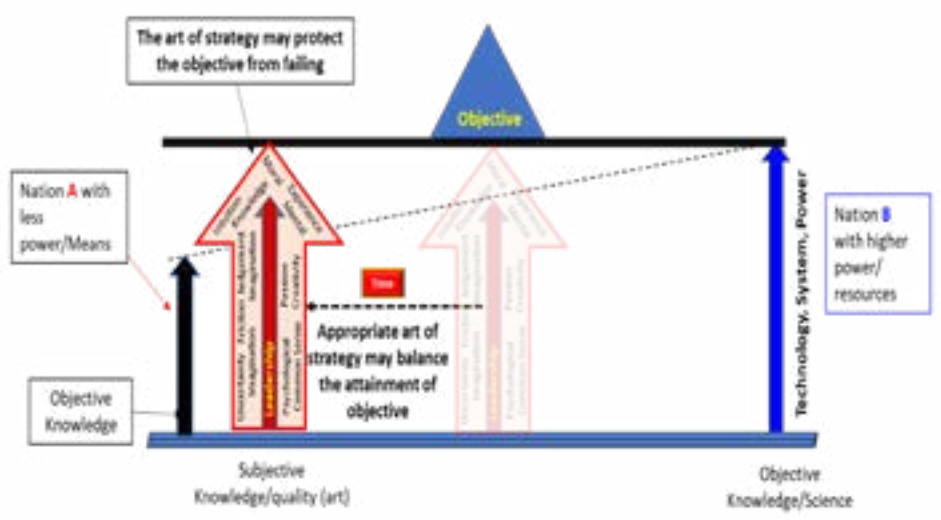


Figure 1 : With a deficiency in 'means', strategy may protect or gain the objective of war through the art of strategy (Prepared by Author)

13. Ibid
14. Ibid
15. Arthur F. 2001. "Toward an Understanding of Military Strategy.", 184

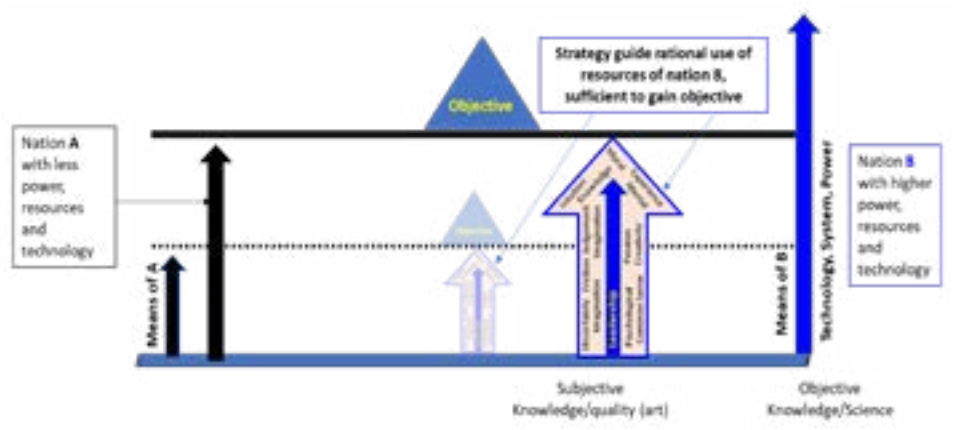


Figure 2 : Use of appropriate proportion of 'means' or use of 'no means' may attain the desired objective which determines the art of strategy
(Prepared by author)

Similarly, figure 2 shows that objective may be attained by rational use of means and 'subjective knowledge (or skill)' in the case of a superior nation. Even, at times, the use of only deterrence may bring an outcome without bloodshed. It is evident from both the figures that the subjective quality or art drives the strategy and reflects the fundamental nature which may not be derived from Lykke or any other theoretical models. If the power of the two nations is similar, it would be the 'art of strategy' that would determine the outcome of the war.

The second argument is related to strategy at a higher level. There is a relationship between the national objective, power and strategy. All nations need to maintain desired fundamental "capabilities denoted as the elements of national powers"[16] encompassing population, military, economy, technology, diplomacy, natural resources, culture etc; all of which fall under the "concept of power"[17]. US Department of Defence also defines almost similar sources of power with "human potential, industry, science and technology, academic institutions, geography, and national will".[18] There are two types of strategies relevant to this power. One,

16. Kitchen, Nicholas. 2022. "The Liberal International Order and American Hegemony." October 11. https://dle.ice.mod.gov.uk
17. Ibid
18. Nathan F Finney "On Strategy: A Primer" ed. (U.S. Army Combined Armed Center Kankas: Combat Studies Institute Press), 2020, 6

'the strategy to enhance power (mostly peacetime) and second, the strategy to win a war. It is argued that 'power' may be defined as the objective knowledge of science. The strategy to gain power is also a science, as most of these elements of national power can be connected through science. Besides, effective use of all this power needs the application of science such as multidomain integration. Some of the strategists also argued that in such cases, the strategy may be "art" at the tactical level but "science" at the strategic level.[19]

The above argument has also been made based on science and technology. In this argument, it is important to note that the strategy to "gain power" and the strategy to "win a war" both are interconnected while each dimension has variables which may impact all.[20] Powers such as human potential, psychology, and national will may not be related to science and cannot be quantified. Besides, "no scientific method exists for determining how much military power is enough, or when the balance is achieved".[21] The use of technological advancement or integration does not necessarily indicate a strategy. The strategy is mostly based on what the political leader thinks is best and what the domestic situation will allow in terms of using capital and political power.[22] In support to this argument, Freedman said, "Strategy is the art of creating power to obtain the maximum political objective using available means".[23] Technological advancement or any other scientific approach has little to do with the fundamental nature of the art of strategy both in the military and at a higher level.

The third and final argument in support to 'strategy as science' is the use of nuclear weapons and modern technology. Use of nuclear capabilities has given a positive note to strategy as a "science", as there is little or no necessity of Karishma and experience there. Apart from the nuclear strategy, the use of high-tech long-range weapon systems and technology such as antiaccess/area-denial (A2/AD) strategy and cyber warfare/operations have also created strong

19. Heyser, "Theory and Practice, Art and Science in Warfare: An Etymological Note", 191
20. Collin S Gray, "Why Strategy is Difficult?" In Strategic Srudies: A Reader by Thomas Mahnken, Joseph Maiolo eds. (Routeledge Taylor and Francis Group, London) 2014, 43
21. Antulio J. Echevarria II, 2017. Military Strategy A Very Short Introduction. New York: Oxford University Press, 34
22. Ibid
23. Gray, "Why Strategy is Difficult?", 6

standpoint in favor of 'strategy as science'. However, the argument goes in favor of art is that the direct use of nuclear weapons is not a strategy. Rather, the existence of strategy fades out only as a 'means' whenever directly used for an objective. The strategy only exists with the 'nuclear deterrence' or 'coercion use of a nuclear weapon' to prevent war,[24] which inherently is an art. On the other hand, A2/AD strategy may be seen as the defensive strategy which is also taking the form of coercion and 'counter-response strategy' for opposing forces. As it A2/AD capabilities of China "hampers the ability of the United States to provide extended deterrence for its allies in the region, the United States and its allies have considered employing their own A2AD strategy, one that would restrict the movement of Chinese and North Korean vessels within the Western Pacific region".[25] Finally, cyber strategy is essentially about enhancing and managing both the defensive and the offensive aspects of cyber power.[26] But, Cyber operations will never single-handedly win a war.[27] The Cyber Network is an operational booster that needs to be weaved into the strategy same as nuclear, electronic or strategic air power.[28] It is important to note that all three above cases as well as the other cases of modern technologies are almost identical. It is difficult to assess the success of deterrence, outcome of cyber operation or consequences of the A2/AD as the events do not take place or as it remains unverified. It is also not possible to demonstrate or disclose why something has not occurred. Here, in principle, the "strategy could no longer be the science of military victory. Rather it would be the art of coercion, intimidation, and deterrence".[29]

Apart from the independent argument of strategy as science, some of the strategists argued that strategy is both art and science or part of the strategy is art and part of it can be defined as science. A contemporary definition provided by the U.S. Joint Chiefs of Staff (JCS) also denoted strategy as the art and science.[30] Prussian

24. Strachan, Hew. 2006. "The lost meaning of Strategy." Global Politics and Strategy (Routledge) 47 (3):33-54

25. Echevarria II, 2017. Military Strategy A Very Short Introduction. 83

26. Daniel Moore. "Offensive Cyber Operations: Understanding Intangible Warfare". (Oxford: Oxford University Press, 2022), 102

27. Ibid

28. Ibid

29. Lawrence, Freedman. "The Evolution of Nuclear Strategy. (New York: Palgrave Macmillan, 2013), 182

30. Michael I Handel. Masters of War: Classical Strategic Thought. (London: Taylor and Francis, 2005), 292

mathematician Heinrich Bülow also "equals' science of war' with 'theory', and 'art of war' with its 'application".[31] It may be said that the system, technology, information, real-time data analysis, space technology, and the use of artificial intelligence have reduced the fog and friction of warfare and suggested accurate options for battlefield commanders and policymakers. As such, it is logical that part of the activities of strategy may be accomplished in a scientific manner. Besides, the systematic development of the war preparation, the logistic requirement and build-up, the use of information and cyber technology etc could be scientifically planned.[32] On the contrary, it is important to note that there was also science and technology when soldiers used different kinds of swords made of different metals, a boat used 'Greek fire' at sea in the ninth century, a torpedo dropped from the sky, or a missile fired from a system. The use of technology, new equipment or system may not define strategy is a science. As the evolving situation and environment are always dynamic, a formula cannot provide an accurate solution. So, strategy is not both art and science; rather, it is the 'art of the strategy' that utilizes science and determines the contemporary nature of the strategy.

Now, let us discuss the points on strategy as an art. First, many of renowned strategists have highlighted the fundamental nature of strategy is an art. Henri Baron de Jomini in 1805, defined strategy as "the art of making war on the map and includes the entire theatre of operations."[33] Helmuth Von Moltke, said, "[Strategy] is the art of acting under the most difficult circumstances".[34] Alfred Thayer Mahan, wrote at the end of the 1800 that war should be seen as an art. Liddell Hart, a British military historian and theorist, said that strategy is "the art of using and distributing military means to achieve policy goals." In regard to art, Clausewitz argued that "war is neither an art nor a science but an act of human intercourse".[35] However, he further argued that in the end, it's an art that calls for creative, not dogmatic, solutions that fit each situation. There are many other front-rank modern strategists who analyzed, explained and written strategy as an art.

31. Heyser, "Theory and Practice, Art and Science in Warfare: An Etymological Note", 190
32. Lawrence Freedman. Strategy A History. (New York: Oxford University Press, 2013), 75
33. Heyser, "Theory and Practice, Art and Science in Warfare: An Etymological Note", 191
34. Robert Greene. The 33 Strategies of War. (New York: Penguin Group Inc, 2006), 51
35. Carl Von, Cluasewitz. On War. London: (Oxford University Press, 2007), 99-100

There are many examples of strategies being adopted by generals throughout the history of warfare. Echevarria II described various strategies used in history, these are annihilation, dislocation, attrition, exhaustion, coercion, deterrence and so on.[36] Robert Greene (Greene 2006) also narrated 33 strategies of war with a historical perspective and highlighted their relevance to warfare. The subjective quality of strategy (art) is so important that perfect planning may sometimes guarantee victory even in the absence of significant combat. A few of the examples are Caesar's Ilerda, Cromwell's Preston, Napoleon's Ulm, Moltke's encirclement of MacMahon's army at Sedan in 1870, the Germans cutting off and trapping the Allies' left flank in Belgium in 1940 etc. All these strategies are the outcome of the experience, vision, creativity and above all, mastery of the war veterans.

There are other dimensions of the art of strategy where "geopolitics, geography and strategy" reflect the geographical aspects of the art of strategy.[37] This is also an art of strategy at grand strategic level. The objective of geopolitics is to highlight the significance of certain geographic patterns in the history of politics. 'Geography or geographical configurations reflects opportunities for policymakers and politicians'.[38] "The extent to which geographical opportunities will be exploited depends on the strategy".[39] The geopolitical decision-making process is also dynamic.[40] and changes with the national interest to geography. Mahan was a great proponent of geography and highlighted the nation's strategy towards sea connecting the geographical chokepoints. When the strategy is considered for the geopolitical objectives with the strategic importance of geography and with the influence of the military, "geography takes the 'master dimension' of strategy".[41] In such cases, technology, information, and technologically derived military power remain as means where the art of "geopolitics can be an instrument of political warfare".[42]

36. Echevarria II, 2017. Military Strategy A Very Short Introduction. 37
37. Gray, "Why Strategy is Difficult?", 2
38. Ibid
39. Ibid
40. Ibid, 3
41. Ibid, 6
42. Ibid, 10

However, the strategists' view on the 'art of strategy', historical examples and geopolitical aspects of strategy does not necessarily qualify it to be an absolute art. But it is evident that to qualify as an art, there is no requirement of any tangible or quantified objects and no theories or formula. It can work in the realm of a huge number of variables and can provide solutions to uncertainty. It may or may not use the technology, nor accept the decision accumulated by the system. The unpredictable future can be brought under imagination on the basis of "practical advice, historical experience, the golden rules of prudent [----] and common sense".[43] As it remains intangible and mysterious; the probability can be an assumption which works everywhere, in all dimensions, with any number of resources. This makes the strongest and fundamental difference between 'strategy as an art' and the 'strategy as science' is that; one may question the validity of the latter, but not the former ('art' of strategy).

To conclude, it can be said that the 'objective knowledge of science' and the 'subjective knowledge of arts (skill)' have created two fundamental divisions – "art" and "science" of strategy. There are valid arguments in favour of and against science and vice versa. The major arguments in favour of science lie with the systematic development of the end-ways-means formula for understanding the strategy. Though the formula is easy to understand, it undermined the fundamental value of the ways and created an end-means mismatch. It also neglected the importance of the balanced use of power. The second argument denoted the strategy is the science of creating power and shows the effective application of power through science. This argument also could not get full just as it deviated from the core strategic question of how much military power is necessary. The third and final argument on the use of nuclear weapons and modern technology as science was also not convincing, as the capabilities of these strategic weapons are used as the "art" of coercion, intimidation, and deterrence.[44]

On the contrary, there are claims in favour of the debate about why strategy is an art. As science could not provide certainties or establish enduring formulas, systems or dogmas; it cannot be science but an art of possibilities. Strategies are

43. Gray, "Why Strategy is Difficult?", 46

44. Lawrence, Freedman. "The Evolution of Nuclear Strategy. (New York: Palgrave Macmillan, 2013), 182

used throughout the history of warfare, independent of its nature and brought success in wars. To date, the ultimate outcome of success remains with the intangible variables such as decision-making, vision, wisdom, intuition, and creativity of the leadership and the way the objective is derived.

It is well understood that some of the activities of strategy such as systematic development of the war preparation, the logistic requirement and build-up, cyber and space technology, information warfare etc are dependent and may be accomplished in a scientific manner. But it does not necessarily indicate strategy as a science. Science, technology, intelligence, and systems - all will always be there for the war as they were before. In fact, the art of using evolving technology under the dynamic condition of war is the strategy. The existence of 'strategy as science' may or may not be there, but the existence of strategy as an "art" will always be there. This is because, it itself, is the fundamental nature of the strategy.

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Biography of the Writer



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Commodore Amanat is married and blessed with a son.

APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) IN THE MARITIME OPERATIONS : AN INSIGHT FOR BN

Commander Meer Baizid Hossain, (G), psc, BN

Artificial intelligence is the future, not only for Russia, but for all humankind. It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world[1].

—Russian president Vladimir Putin, 01 September 2017

Abstract

Artificial Intelligence (AI) is playing an increasing role in the military operations transcending through its application in the science and business sectors. Looking through the kaleidoscope of maritime operations at AI, huge prospects, potentials and uncertainties can be envisioned. An incremental development is also evident in the Navies around the world as far as AI is concerned. Flying the Naval ensign in the Bay of Bengal(BoB) and beyond as a three dimensional Navy, now in 2023 as BN envisions to become a "Smart Navy for Smart Bangladesh", it is thus imperative to explore the potentials of AI rather ignoring it. While there are many dimensions of discussing AI, this article is going to give an insight for BN in light of the contemporary developments and applications of AI in the maritime operations by the world's leading Navies in order to harness the potentials of AI through adopting a comprehensive approach.

Introduction

Artificial Intelligence (AI) has become a buzzword nowadays in the day to day life. As we became used to with the *Siri* for iPhone or consulting *ChatGPT* for assisting us in making our life easier, the military purview of AI is also expanding quickly. As it is experienced with Apple's Siri vis-à-vis a customer, the military operators need not to be always the master of computer programming or algorithm. Rather the operating system of AI will facilitate the operator using it having a certain level of knowledge on using the operating systems. Therefore, when a military operator is reasonably educated on computer assisted operations, usage of AI in the military field will be much for effective. Due to the vastness of the ocean environment coupled with the hostility, unpredictability and uncertainty therein, application of

1. https://www.cnn.com/2017/09/01/world/putin-artificial-intelligence-will-rule-world/index.html

AI in the maritime operations is actively considered. The future of naval operations is likely to involve a combination of human expertise and AI-driven technologies, resulting in a more capable and adaptable naval force. These technologies can help naval commanders make informed decisions, enhance situational awareness, and improve the overall effectiveness of naval missions. AI is a big field. Thereby, in order to start from the scratch, BN needs to adopt a comprehensive approach to set the near-term priorities regarding how to go with the fields of AI, build the human resources; develop expertise gradually while sensitizing the BN personnel and building capacity concurrently developing a roadmap.

Defining AI

The definition and understanding of AI have evolved significantly since the field's inception. The Dartmouth Conference in 1956 marked a significant milestone in the history of AI, and it brought together pioneering researchers to explore the possibilities of AI. The original goals of AI, as stated at the conference, were indeed broad and encompassed a combination of robotics, neural networks, and programming. However, the field has since evolved in various ways, and its definition has become more refined. In order to define AI, Russell, S., & Norvig, P.(2015)[2], adopted the four-approach that encompasses eight definitions of AI while thinking and acting both humanly and rationally.

Table 1 : Some definitions of AI, organized into four categories

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

(Source : Russell, S., & Norvig, P. (2016, May 5). Artificial Intelligence, A Modern Approach[3])

2. Russell, S., & Norvig, P. (2016, May 5). Artificial Intelligence, A Modern Approach
3. Russell, S., & Norvig, P. (2016, May 5). Artificial Intelligence, A Modern Approach

From the above approach, it can be deduced that AI involves creating and developing the operating system that enhances the performance of activities in manifolds which require a certain degree of human intelligence.

Simplified Concept of AI

The simplified conceptual model of an AI system has four layers, each building upon the previous one to impersonate human intelligence. While it simplifies the concept, it is important to note that the relationship between these layers is more complex and interconnected in practice. Here is the breakdown of each layer:

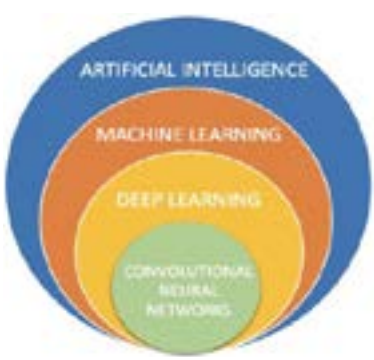
Neural Networks : This is indeed the foundational layer of many AI systems. Neural networks are composed of interconnected nodes, or artificial neurons, that process data, recognize patterns, and perform mathematical operations. They serve as the building blocks for AI techniques.

Deep Learning (DL) : Deep learning, which is a subset of machine learning, involves using deep neural networks with many layers. DL contains the AI's ability to process images, speech, and language.

Machine Learning (ML) : Machine learning is a fundamental layer that enables AI to learn and adapt without the need for human input.

AI : The topmost layer in the model is where AI operates, making decisions based on the information it has absorbed, stored, and processed.

Figure 1 : Understanding the Layers of AI



(Source : www.researchgate.net/figure/Layers-of-Artificial-Intelligence)

In practice, these layers are highly interconnected. Deep learning and machine learning techniques are often integrated into AI systems to enable decision-making based on processed data, which may include image analysis, language understanding, and much more.

Categories of AI : AI is divided into three major categories[4], Artificial General Intelligence (AGI), Artificial Narrow Intelligence (ANI) and Simple AI. It is important to note that the terms AGI and ANI refer to the scope and capabilities of AI systems. Achieving AGI, which replicates human-like thinking and understanding across a wide range of tasks, remains a long-term goal and a subject of ongoing research. In contrast, ANI systems are highly valuable for solving specific problems and are widely employed in various industries. Simple AI refers to machines that can do calculations through analog or digital functions faster than most humans could. For example, Phalanx CIWS is a simple AI machine that, in full-auto mode, makes a decision based on its own data collection whether to engage an incoming target—to shoot or not to shoot. In this sense, it acts as a human would when provided with the same data. Phalanx CIWS is termed as simple AI as because it is not learning from its error in identifying the anti-ship missiles or friendly aircraft. Today's military sector focuses on enhancing the ANI that is enhancing performance of the simple AI based system.

Glancing at AI through the Kaleidoscope of Maritime Operations

US Navy

In December 2018, the Chief of Naval Operations , US Navy(USN) released a *Design for Maintaining Maritime Superiority*[5]*, Version 2.0*, which acknowledged the challenges to the competitive advantage, the nature and scope of twenty first-century global maritime competition, and the accelerating advances in technology that are resulting in disruptive rates of change. To meet this challenge, the design calls for the USN to become more agile, compete in ways that are sustainable, and be able to fight as part of a joint force that can control the high end of maritime conflict. This is to be accomplished through partnerships with

4. Tangredi, S. J., & Galdorisi, G. (2021, March 15). AI at War. Naval Institute Press
5. https://media.defense.gov/2020/May/18/2002301999/-1/-1/1/DESIGN_2.0

industry, academia, and research institutions and specifically requires fast track initiatives to accelerate the application of AI/ML in support of distributed maritime operations. The Department of the Navy (DoN) fiscal year (FY) 2020 budget submission of $205.6 billion is an overall increase of $9.5 billion (4.6 percent) from the FY19 enacted budget.[6] The increased funding is intended to restore the DoN's competitive advantage and will field a larger and more formidable force. The DoN FY20 budget targets the development of unmanned aircraft and vessels, ship-based lasers, big data analytics, AI, and cyber security, as well as Command, Control, Communications, Computers, and Intelligence (C4I) to address multiple dimensions of conflict. Therefore, it can be deduced that the US DoN is actively considering the significant paradigm shifts that big data analytics, AI, and ML provide to meet the national security requirements.

Figure 2 : Unmanned Maritime Systems with Classification and Primary Application



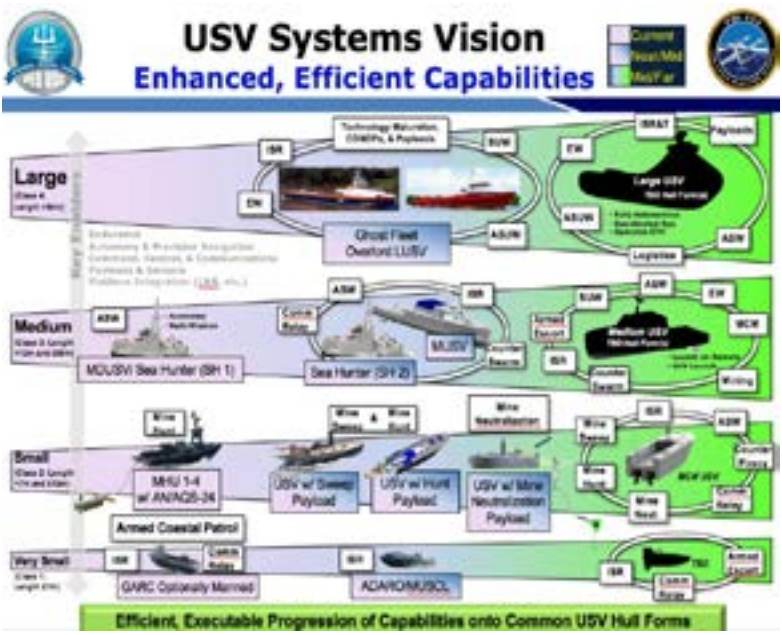
(Source : Unmanned Systems Integrated Roadmap FY 2013-2038, Department of Defence[7])

6. https://news.usni.org/2019/03/12/document-department-navy-fy-2020-budget-summary
7. https://apps.dtic.mil/sti/citations/ADA592015

USN is developing and using the AI-based naval combat systems and AI-based naval vehicles. AI-based naval vehicles in terms of Unmanned Surface Vehicles/vessels (USVs) and Unmanned Undersea Vehicles (UUVs) are forming the Unmanned Maritime Systems (UMSs) (Figure-2). It is to be noted that AI-based naval combat systems require comprehensive human-machine collaboration.[8] On the other hand, AI-based naval vehicles may not always have a human supervisor. AI-based naval combat systems help USN to improve operational capability facilitating rapid decision making. It thus enables to effectively respond to a wide range of maritime challenges, including threats from potential adversaries, piracy, smuggling, and humanitarian crisis. These objectives are crucial for maintaining naval superiority and ensuring national security in the maritime domain.

USN is also deploying USV like Sea Hunter for large area surveillance operations to track submarines and relay the information back to a nearby vessel.

Figure 3 : General Information and Capabilities of USV Sea



Source : https://news.usni.org/2019/04/29/sea-hunter

8. Tangredi, S. J., & Galdorisi, G. (2021, March 15). AI at War. Naval Institute Press

By being able to operate for extended durations and perform missions like tracking submarines, it contributes to enhancing maritime security and surveillance capabilities while reducing the risks and costs associated with human crews onboard.

Royal Navy

During **Formidable Shield 2021,** Royal Navy Ships (Type 45 Destroyers, HMS LANCASTER and HMS DRAGON) trialled the capabilities of its ROKE's (Roke Manor Research) autonomous threat monitoring system, STARTLE.[9]

Figure 4 : Trial of STARTLE by Royal Navy Ships during Formidable Shield 2021



(Source : STARTLE, Roke UK, https://www.roke.co.uk/what-we-do/intelligentsensors-and-unmanned-systems/startle)

This AI architecture enables operators to monitor and rapidly react to threats across multiple sensor feeds. Key benefits of this system include reducing operator fatigue while maximising operational effectiveness.

PLA (Navy)

PLA (Navy) is also planning to provide its nuclear submarines with an AI based decision-support system to provide autonomous decision support, enhance situational awareness and reduce cognitive load of its submarine commanders. Moreover, China launched an unmanned ship, named Zhu Hai Yun[10], on 18 May

9. STARTLE, Roke UK, https://www.roke.co.uk/what-we-do/intelligentsensors-and-unmanned-systems/startle

10. https://asiatimes.com/2022/06/china-floats-first-ever-ai-powered-drone-mothership

2022 that can be controlled remotely and navigate autonomously in open water and carry dozens of drones, submersibles, and other vessels for conducting ocean research. In 2016, a Chinese UUV, Qianlong No. 2, successfully completed its first exploration in the southwest Indian Ocean for sulphide deposits. Such submersible vessels can be used for monitoring movements of submarines and can even be deployed to carry out mine laying missions near Indian territorial waters.



Figure 5 : Trial of Chinese UUV, Qianlong No. 2 by PLA (Navy)
(Source : http://en.people.cn/n3/2016/0112/c90000-9002025.html)

Indian Navy

The Government of India constituted an AI taskforce to explore various arenas in which AI can enhance conventional capabilities. During the Chennai Defence exposition in April 2018, Indian Prime Minister Narendra Modi remarked that new and emerging technologies like AI and Robotics would perhaps be the most important determinants of defensive and offensive capabilities for any defence force in the future.[11] In another event organized in 2022 termed as 'AiDef'[12],

11. https://timesofindia.indiatimes.com/india/india-moves-to-develop-ai-based-military-systems/articleshow/64250232.cms
12. https://timesofindia.indiatimes.com/topic/aidef/news

he reemphasised the requirement of the development process to incorporate AI in the defence to promote uniqueness in the defence in order to become a future-ready force. In 2018, India's first AI-focused research institute has been opened in Mumbai.[13] It is noteworthy that some Indian Universities and research agencies have already developed unmanned vehicles that can be put under the disposal of the Indian Navy.

Figure 6 : Autonomous Underwater Vehicle (AUV), NEERAKSHI



(Source : https://www.hindustantimes.com/india-news/india-launches-neerakshi-autonomous-underwater-vehicle-for-mine-detection-101690636002474.html)

In July 2023, Garden Reach Shipbuilders and Engineers (GRSE), an Indian state-owned shipyard, launched an Autonomous Underwater Vehicle (AUV) named NEERAKSHI. The vehicle can be used for a variety of functions such as mine detection, mine disposal, and underwater survey. It is a collaborative effort between GRSE and Aerospace Engineering Private Limited (AEPL).[14]

13. https://m.economictimes.com/tech/ites/indias-first-ai-research-institute-opened-in-mumbai/articleshow/63000704.cms

14. https://thediplomat.com/2023/08/taking-stock-of-indias-evolving-unmanned-undersea-capabilities

A Comprehensive Approach to Harness AI in BN

AI is likely to become increasingly common in the maritime battle-space as navies continue to explore and adopt AI-driven technologies to enhance their capabilities in the evolving maritime environment. The contemporary developments and applications of AI in the maritime operations by the World's leading Navies in order to harness the potentials of AI are also clearly evident. These technologies can help naval commanders to make informed decisions, enhance situational awareness, and improve the overall effectiveness of naval missions reducing crew fatigue and cognitive burden. AI, considering as a big field, in order to harness its potentials as a beginner, BN needs to adopt a comprehensive approach.

- Initially, existing knowledge on AI may be shared in order to sensitize and educate BN personnel on AI through conducting workshop/ seminar in all naval areas. This is a crucial first step to raise awareness and understanding of AI and its potential applications within the naval context.
- After the initial awareness-building workshops, BN may consider offering more comprehensive training and education programs in AI for interested/ shortlisted personnel. If way include courses and practical exercises in home/ abroad to develop AI expertise.
- Sharing of existing knowledge on AI can include providing information on AI concepts, capabilities, and the potential benefits for maritime operations.
- It is essential to consolidate and prioritize the issues and challenges related to AI integration within BN. This step involves identifying the specific areas where AI can provide the most value and addressing any concerns or hindrance.
- Once the issues are consolidated, BN needs to set clear priorities. This will help in focusing efforts and resources on the most useful and high-impact areas where AI can be applied.
- Creating a roadmap outlining the steps and milestones for AI implementation. The roadmap should include short term, mid-term and

long-term goals, allowing for a structured approach to AI integration over time. The roadmap should align with the vision and strategic goals of BN. The issues discussed/ raised may be consolidated to address the priorities, setting up the field for R&D and subsequent capacity building and addressed in the roadmap.

- According to the roadmap, the next step would be to establish the AI cell at Centre for Naval Research and Development (CNRD) under the supervision of Directorate of Naval Information and Technology (DNIT). This cell could serve as a dedicated unit for AI research, development, and integration into naval operations. The primary role of AI cell would be to conduct Research and Development (R&D) activities related to AI in BN's context. This might include developing AI applications for autonomous systems, data analysis, and decision support taking into due considerations of the ongoing developments of World's leading Navies.
- As AI technologies are developed and tested, they can be integrated into various aspects of naval operations to enhance efficiency, decision making, and overall capabilities.

Figure 7 : A Comprehensive Approach to Harness AI in BN



(Source : Author's Construct)

- Collaboration with academic institutions, research organizations, and AI experts can be beneficial for staying up-to-date with the latest AI advancements and best practices.

- Concurrent collaboration with Armed Forces Division (AFD) and integration of Subject Matter Experts (SMEs) (civil/ military from home/ abroad) may be explored. Involving small and medium-sized enterprises (SMEs) from both the civilian and military sectors, whether from within Bangladesh or abroad, can bring specialized skills and innovative solutions to the AI projects.

- Continuous training and awareness programs can ensure that BN personnel stay informed about the evolving field of AI and its application in the maritime domain.

- As part of the roadmap, capacity building should be a fundamental component. This includes training BN personnel, engineers, and other stakeholders in AI concepts, technologies, and applications.

The proposed steps align with a structured and informed approach to integrating AI into maritime operations, ensuring that personnel are well-prepared to leverage the benefits of AI. By following this comprehensive approach, BN can effectively harness the benefits of AI aligning her vision to become a "Smart Navy for Smart Bangladesh" in the long run.

Concluding Remarks

In order to keep pace with the ever-changing technological development, countries around the world are embracing the potentials the AI. Considering the vastness of the ocean environment, AI is well suited for maritime operations which is observed by the intent and actions of the World's leading Navies. In materializing the vision, BN also requires to address the issues of AI. As maritime operations are enabled by AI, BN needs to continually address its prospects and potentials.

As a beginner in this field, basic understanding of the layers and categories of AI will facilitate to make the preferences or options for developments. The leading Navies of the world are actively considering and allocating budget with a long term R&D in the field of AI. Considering the complexity, requirement of R&D, Navies are collaborating or partnering with defence industries being patronized by the Government. In order to develop AI in BN through a comprehensive approach, the first step is to raise awareness and understanding of AI and its potential applications within the naval context. Sharing of existing knowledge on AI can include providing information on AI concepts, capabilities, and the potential benefits for maritime operations.

Thereafter, BN needs to develop a roadmap which should include short term, mid-term and long-term goals, allowing for a structured approach to AI integration over time. The roadmap should align with the vision of BN. BN needs to develop capacities in terms of R & D, aware personnel about priorities to be set in the fields to focus and research. Developing an AI Cell to think about AI in order to apply it in the field of maritime operations may be undertaken by BN. Observing the applications and development of AI in different Navies of the world will give greater insights to set priorities. Collaboration with SMEs are to be duly considered for theoretical and practical capacity building. By following the comprehensive approach, BN can effectively harness the benefits of AI aligning her vision to become a "Smart Navy for Smart Bangladesh" in future.

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Commander Meer Baizid Hossain, (G), psc, BN was commissioned in Bangladesh Navy (BN) in 2002. He was awarded with the Sword of Honour and Osmani Gold Medal for all-round performance as a Midshipman. In 2006, he completed Principal Warfare Officer Course from School of Maritime Warfare and Tactics. He also completed Surface Warfare Officer course from Rhode Island, USA in the same year. In 2010, he completed United Nation's Staff Officer's course from Sweden. From 2011 to 2012, he participated in the United Nation's Peacekeeping Mission in Ivory Coast as a Military Observer. In 2014, he completed Gunnery Specialization course. He completed Civil-Military Cooperation course from Turkey in the same year. In 2015, he served as a Principal Warfare Officer onboard Bangladesh Navy Ship SOMUDRA AVIJAN and brought the ship from USA to Bangladesh. He graduated from Defence Services Command and Staff College, Mirpur, Dhaka in 2017-2018. He completed his second Staff course from Kuwait in 2018-2019. He served in different sea appointments in five Frigates, Offshore Patrol Vessels, patrol craft and Large Patrol Craft of Bangladesh Navy for about 9 years. He served as a Staff Officer in the Bangladesh Armed Forces Division and Deputy Director Naval Plans at Naval Headquarters. He was an instructor in the School of Maritime Warfare and Tactics, the Gunnery School and the Bangladesh Military Academy. He visited USA, Saudi Arabia, Qatar, Kuwait, Turkey, Sweden, Ivory Coast, Indonesia, Malaysia, Guam, Hawaii, Philippines, India and Vietnam. Commander Baizid is happily married and blessed with two daughters. Presently he is serving as the Executive Officer of BNS SHADHINOTA.

ASSESSING THE EFFICACY OF NAVY'S PEACETIME OPERATIONS AGAINST NON-TRADITIONAL MARITIME THREATS IN THE EVOLVING FOURTH INDUSTRIAL REVOLUTION : BANGLADESH PERSPECTIVE

Commander Abu Sadat Mahmud Safeer Chowdhury, (G), NPP, afwc, psc, BN

Abstract

Today the world has entered the era of Fourth Industrial Revolution (4IR) influencing all areas of our society, way of thinking and lifestyle. However, it has also become a security concern, as the non-state actors could exploit 4IR to their illicit gain. Likewise, there is possibility these actors may capitalize 4IR and proliferate non-traditional maritime threats in Bay of Bengal (BoB). Therefore, the study was aimed to identify the gaps in Bangladesh Navy's peacetime operational capability and draw the right approach to counter non-traditional threats in 4IR context. The findings revealed that 4IR is gradually transforming the nature of non-traditional conflicts creating new scope for the non-state actors to play to their whims. Such transformation of threats uncovered BN's capability gaps, lack of organizational set up, absence of data base and coordination gap with other stakeholders. To address those gaps, a phase wise approach divided in short term (5 years) and long term (10 years) has been proposed incorporating relevant maritime stakeholders with Navy taking Government's support and approval.

Key Words *: Fourth Industrial Revolution (4IR), Bangladesh Navy's peacetime maritime operations, non-traditional maritime threats, Bay of Bengal (BoB).*

Introduction

Industrial Revolution – one of the greatest leaps forward in modern history has transformed our way of life into a society influenced by machine and technology. Today the world has entered the era of Fourth Industrial Revolution (4IR). The term was coined first by Klaus Schwab in 2016, founder of World Economic Forum. In his words, "It is the fusion of technology that is blurring the lines between physical, digital and biological sphere" (Schwab, 2016). To break that down, it is the

combination among Artificial Intelligence, Internet of Things, Automated Machine Learning, Big Data Processing, Cyber Security, Augmented Reality, Genomics, Face Recognition and many more. This whole of issue has influenced not only a specific industry, but all areas of a society and lifestyle. On the same tone, 4IR is in the process to further transform the means and ways of military operations as well (Barno & Bensahel, 2018). This brings to the question whether currently Navies around the world are being able to keep pace with rapid growth of 4IR or not.

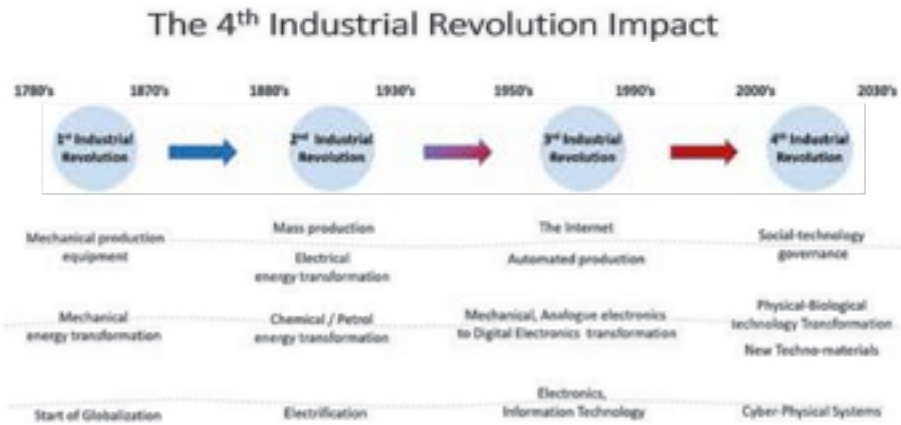


Figure 1 : Brief Overview of 4IR
Source : (Skilton & Hovsepan, 2018)

In today's 21st century, conflicts at sea are no more limited to traditional threats. Rather in the process of geo political rivalry and disruption in socio economic structure, there have been proliferation of non-traditional maritime security threats reshaping the overall security environment (Aswani, 2020). The Indian Ocean Region (IOR) and Bay of Bengal (BoB) is also no exception and increasing presence of non-traditional maritime threats are being felt around the littorals. In this connection, there is every possibility that the non-state actors may capitalize the benefits of 4IR to their advantage to proliferate non-traditional maritime threats at sea.

The above raises the question, if Bangladesh Navy (BN), the premiere maritime security organisation is prepared to deal such new form of threats

influenced by 4IR. In other words, the non-state actors is likely to outsmart BN at sea if they can capitalize 4IR before BN is prepared to do so. Therefore, the paper is aimed to identify the gaps in Bangladesh Navy's peacetime operational capability and draw the right approach to counter non-traditional threats in 4IR context. In this regard, the study first analysed the influence of 4IR on non-traditional maritime threats. Then it identified BN's capability gaps to counter non-traditional threats in the era 4IR. Finally, it has suggested measures for redesigning peacetime operations along with a model design proposed for implementation.

Influence of 4IR on Non-Traditional Maritime Threats

Disruption to Maritime Shipping and Infrastructure through Cyber Attack

While Maritime shipping industry has been benefitted with opportunities of 4IR, it has also become ripe for disruption through AI and cyber-attacks. The industry produces lot of data for navigation and communication. Loss of those data creates vulnerability in terms of port and ship's safety (Davies, 2021). Evidence suggests that since 2017, four large shipping companies namely MAERSK, Mediterranean shipping company, COSCO and CMA CGM were hit by cyber-attacks (Cimpanu, 2020). Besides, there were state sponsored cyber-attack such as Iran's port facilities at Bandar Abbas by Israel on 09 May 2020 that caused the port infrastructure and its activities to come to grinding halt (Warrick & Nakashima, 2020).

Rise of Maritime Terrorism

The term was first coined in 2000 when USS Cole was attacked by Al Qaeda in Yemen. Recently, with the advent of technology the terrorists have undertaken smarter approaches. One glaring example is the sea based terrorism in Mumbai, 2008 when a series of attacks occurred simultaneously in 5 locations killing 165 persons while injuring 304 (Singh, 2019). Although timing of attack was much before then term 4IR was invented, but evidence suggested that the terrorists used GPS instruments and satellite phones with internet to track and navigate their path, and maintain communication with their hosts and peers.

Evolution for Piracy, Armed Robbery and Petty Theft

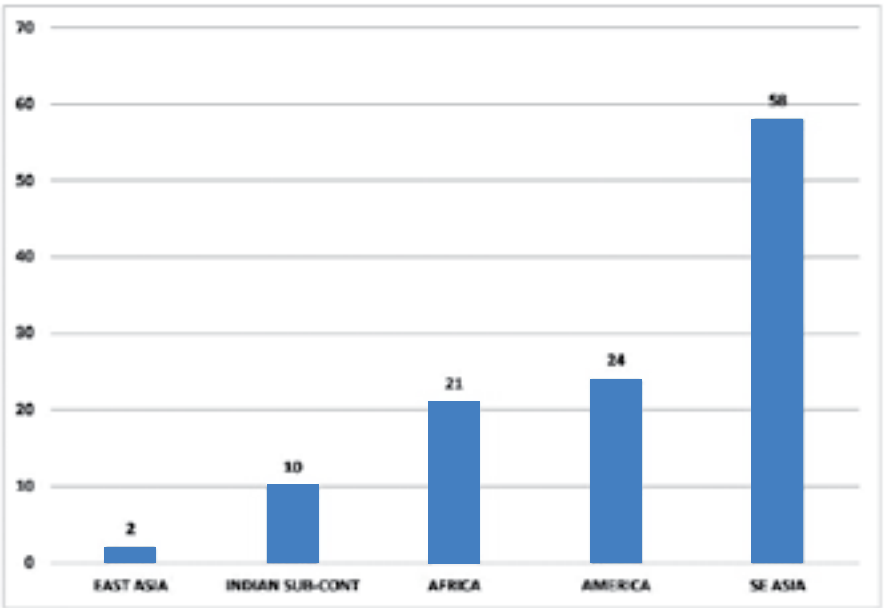


Figure 2 : Total incidents of Piracy in 2022 as per region.
(Source: IMB Annual Report, 2022)

With advent of technology the maritime piracy has made evolution. Evidence shows that, the pirates monitor various software app 'Marine Traffic System' or 'Ship Finder' etc to those reveal huge amount of details including the type and of vessel, nature of cargo and their proposed routes. Pirates kidnap and collects ransom by transferring money by bitcoin or in online anonymous account using it harder to trace back. (Anon., 2020). The above chart gives a brief figure on the number of attacks reported by region in 2022. Another reason for such occurrence is the weak law infrastructure and technology of the coastal states make it harder for them to apprehend the pirates (Pheng, 2020). This why the number of attacks remain proportionately high in areas where govt policing capability is relatively weak. In Bay of Bengal, the figure of armed robbery is relatively low (IMB Annual Report, 2022). However soon these actors may acquaint themselves with technology and conduct smarter attacks on the shipping.

Modifying Tactics by Human Traffickers

Human traffickers through GPS capabilities and smart phones are able to maintain network within the syndicate. The victims are perpetually being tracked and made digital prisoners with their private pictures and information. Then, technology has made it easier to make online payment methods instead of carrying hard cash. (Gupta, 2019). In Bangladesh, the human trafficking has been on the rise since the exodus of 1.1 million Rohingyas from Myanmar. Since 2019, official report suggests that there were around 4400 trafficking cases of Rohingyas (Shishir, 2021). In May 2020, BN ships rescued 277 Rohingyas after being blocked by Malaysian authorities at sea (Bhuiyan & Shawon, 2020). But in most cases, those trafficking went unnoticed due to their use of superior technology and networking through free access over internet.

Exploitation of Fishing

Like other non-traditional threat, people involved in IUU fishing have resorted to technological means of 4IR to catch fish and other resources. These include using fish finder integrated with GPS to track and locate the fishing density and then use AI to interpret the data and pattern of fishing zone (Bajpai, 2017). Similar incidents are happening within the EEZ of Bangladesh where large group of IUU fishing are being detected especially in the western flank. By employing such techniques, it is estimated that the rich fishing zone is gradually being depleted due to those illegal fishing caused with assistance of modern techniques of 4IR.

Addressing 4IR by Other Navies

US Military is advancing for innovation in key areas of 4IR. They are autonomous learning, human-machine collaboration, advanced unmanned operations and network work enabled automated weapons (Mitchell, 2018). Chinese Navy are progressing towards digitization through building capability on electronic warfare, information warfare and smart munitions (Zhongchang, et al., 2019). Looking towards the midsized Navy, Singapore has embraced by inducting AI, maritime drones and unmanned surface vessel. (Liang, 2018).

Indian Navy is also focusing on improving network centric operations through satellite, unmanned marine system, AI, cyber security and technologies to keep balance with the emerging technologies of 4IR.

Despite the advancement made by the navies mentioned above, scholars admitted that, small and midsized navies do not have the resources to implement 4IR's benefits on a wide scale (Liang, 2018). Therefore, there is a need to look for pragmatic solutions to move forward in the age of 4IR.

BN's Capability Gaps to Counter Non - Traditional Maritime Threats in 4IR

Lack of Organizational Set up to Counter Cyber Threat

Currently BN have limited capability to deal cyber threat. Besides, the operational security of BN email or information network is not fully tested to its capacity making it vulnerable to cyber-attack. The lessons of cyber-attack on Bangladesh Bank, financial institutions and BTRC occurred in recent past suggest that any vested group can repeat the same extracting critical information from BN's database.

Limited Surveillance Capacity

The principle means of conducting surveillance is through ship borne radars. There are also EW suits in some of the ships but could not develop EW library yet. Therefore, classification of a detected contact is not fully effective despite having EW gadgets onboard. The maritime air surveillance has improved than previous but needs more capability development in terms of training and utilizing sensors synchronized with surface fleet. In summary, BN is quite short of having required surveillance capability in a 4IR environment.

Gaps in Sharing Information Among Stakeholders

Many of the capability development among security stakeholders in coastal domain run in piecemeal often resulting in gap or duplication. For example, both BCG and DG shipping are progressing to set up coastal surveillance network and

EGIMNS respectively for maritime safety and security. Both the systems have some commonalities like AIS and VHF communication network. Hence the two projects could have been merged into one to reap more benefits.

Lack of MDA

There are many maritime communities dependent on the sea for transportation, fishing, extraction of resources and other Blue Economic activities. Unfortunately, there is not much data base available on the maritime domain to the security stakeholders at sea. Different Ministries and their departments have the corresponding information and data but they are yet to be integrated for sharing. Absence of such data makes it difficult for the Navy to maintain MDA at sea creating gaps for the non-state actors to use sea for illicit gain.

Unfamiliarity of 4IR

4IR is still considered a buzz word and its security concerns are yet to be comprehended. During the study, few could make arguments regarding how much BN is short of capability with respect 4IR, whether such capability gaps could make BN vulnerable against the non-state actors and what BN should do to prepare herself to keep pace with 4IR. In other words, there is lack of awareness on the impending 4IR.

Summary

Studying all these gaps/weakness, emergence of 4IR is likely to creating scope for the non-state actors to exploit non-traditional threats turning BN's peacetime operational capability vulnerable. Therefore, it is important to address the BN's shortfalls through a road map with respect to 4IR in the BoB which shall be discussed next.

Redesigning BN's Peacetime Operational Capability

This portion will discuss ways and means to be adopted for redesigning the peacetime operations against non-traditional maritime threats in 4IR. To move forward, a phase wise approach has been designed setting **1-5 years** for short term

and **5-10 years** as long term. The short term measures are **categorized further as capacity building, conceptual development and regulatory actions.** The following paragraphs shall make an elaborate discussion.

Short Term Measures: Capacity Development

Security against Cyber Threat

With advent of technology, BN is gradually shifting in preserving and sharing information to software base application. Meanwhile, prominence of cyber threat in 4IR is huge and there are victims of cyber-attack in Bangladesh. While responsibilities for cyber warfare necessitates a joint approach, but ensuring protection and securing own information will rest on individual services. Thereby, a heuristic suggestion to ensure security against cyber threat is as follows :



Figure 3 : Heuristic view for Operation security against cyber threat/warfare
(Source : Author's construct)

Acquisition of Surveillance Drones

Drones are force multipliers for maritime surveillance to locate various transnational crimes like human trafficking, IUU fishing, and armed robbery. Various Navies in the neighbourhood like India, Myanmar have acquired drones already. Accordingly, BN should continue focus to construct and acquire mid/ short range shipborne surveillance drones.

Develop Android / Apple App

Android or apple application software are a great invention to connect people. The same can be applied among the sea faring communities as well. For example, Royal Malaysian Navy have introduced an app named K3M for maritime stakeholders through cell phone network around its coast (Bunyan, 2018).The coastal areas of Bangladesh have a large cell phones network having coverage almost up to 10 nm out towards sea. A big sea faring population engaged in economic activities are confined close to coastal areas and many of them are now using smart phones. Based on the above, there is opportunity for BN to introduce App through incorporating necessary navigational information and infrastructural facilities. Such measure is expected BN to have much better maritime picture, connect seafarers and respond to any crisis immediately.

Expansion of EW Library

Many of the BN's fighting platforms' combat information system relies on data library to suggest whether a target is neutral, hostile or unknown. In this regard, EW data library having electromagnetic signatures of all sea going vessels both foreign and domestic would be helpful during both and war and peacetime for classifying targets. Therefore, BN should immediately set up organisational framework for preserving EW signatures.

Preservation of Big Data

Many of the proposed measures such as radar surveillance, EW library, Software app, AIS will generate huge amount of data containing electronic footprint of vessels, sea fares identity and their background information. In

age 4IR, data has become a commodity and possession of data could become invaluable to identify intruders/threats. Therefore this will necessitate BN to develop required facilities for preserving big data**.**

Short Term Measures : Conceptual Development

Human Resource Development

One of the foremost thing required is to developing human resources through education on 4IR. This includes steps to convince senior leadership, create awareness among officers and men followed by incorporating training in various levels. In this regard, a schematic proposal for human resource development is as follow :

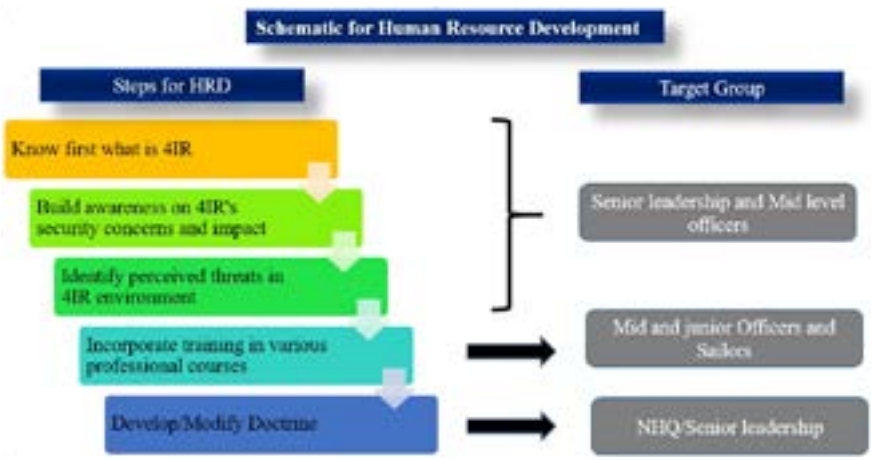


Figure 4 : Schematic Proposal for human resource development
(Source : Author's construct)

Build Awareness Among the Maritime Stakeholders

Like BN, the subject 4IR is also a buzz word for most of the maritime stakeholders. Therefore, there is a need to make 4IR and its security concern aware conceptually among the decision makers of various maritime organisation. This is to be followed by incorporating training and capacity building of respective organisations.

Short Term Measures : Regulatory Actions

Mandatory Installation of AIS in Sea Going Vessels

IMO regulation prescribes ships over 300 gross tonnages to carry AIS. Therefore, it is important to make regulations to mandatory install all such vessels with AIS so that the Navy, BCG and other authorities can communicate, track and monitor ships and provide assistance in distress. Therefore, it is important to implement the said regulations soon to have a legal framework for enforcement of AIS installation.

Establish Maritime Regulatory Body

Establishing a maritime regulatory body is essential to give the maritime security stakeholders a regulatory framework, directives to exchange information, integrate data, share responsibility and coordinate activities to ensure maritime security. In the age of 4IR, such sharing of data is crucial as no single service or agency can alone address the evolving nature of non-traditional threats at sea. The establishment process of a regulatory framework is time consuming. Therefore, experts suggested that such a maritime regulatory body with strong pressure may be set up directly under PMO secretariat to synchronise maritime security at sea among Services, Intelligence and Maritime agencies. A broad flowchart for setting up regulatory body includes the followings :

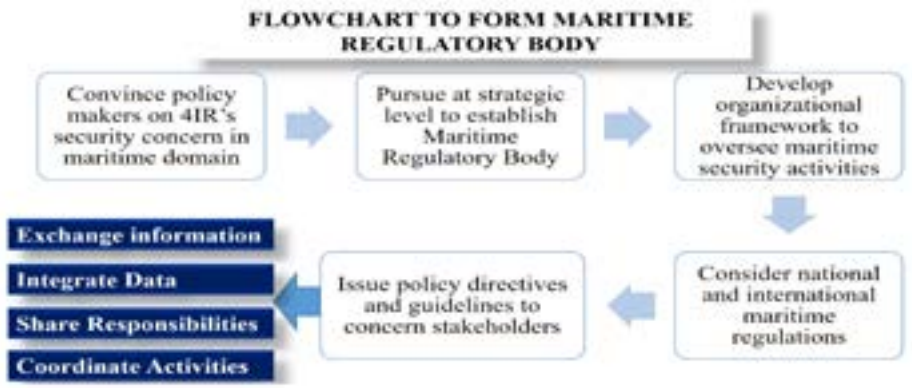


Figure 5 : Flowchart to form Maritime Regulatory Body for Security
(Source : Author's construct)

Summarizing the Short Term Measures

The summary of short term measures are combined in the following table below :

Ser	Capacity Building	Regulatory Actions	Conceptual development
Lead Resp	**BN**	**Govt**	**Govt + BN**
1	**Security against Cyber Threat**	**Establish Maritime Regulatory Body**	**Build Awareness among Maritime Stakeholders**
Effects	Protecting and sharing of information through secured means	Set authoritative framework and directives to exchange information, coordinate and share responsibility among maritime stakeholders	Make 4IR and its security concern aware among the maritime stakeholders
2	**Acquisition of Surveillance Drones**	**Mandatory Installation of AIS**	**Human Resource Development**
Effects	Cover wider range for maritime surveillance with lesser time	Track and monitor ships and provide assistance in distress	Educate various level of officers while creating convincing awareness among senior leadership
4	**Develop Android/Apple App**		
Effects	Connect with sea faring population for security and safety		
5	**Expansion of EW Library**		
Effects	To classify target friendly, hostile or unknown		
6	**Creation of big data base Infrastructure**		
Effects	Possess vessels' electronic signature, sea farers identity and their background information		

Table 1 : Summarisation of Short Term Measures
(Source : Author's construct)

Long Term Measures (5-10 years)

Establish Shore based Radar Surveillance Network

Absence of coastal surveillance leaves large area of BoB to remain unwatched. Therefore, establishment of shore based radar surveillance network will enhance BN surveillance capability. Once established, the network is expected to classify surface contacts, including low altitude air targets UAV/drone, etc. In the age of 4IR, such network will enhance MDA, identify unauthorized presence of objects, and defend coastal areas through early warning. The following gives a broad overview of the system composition :

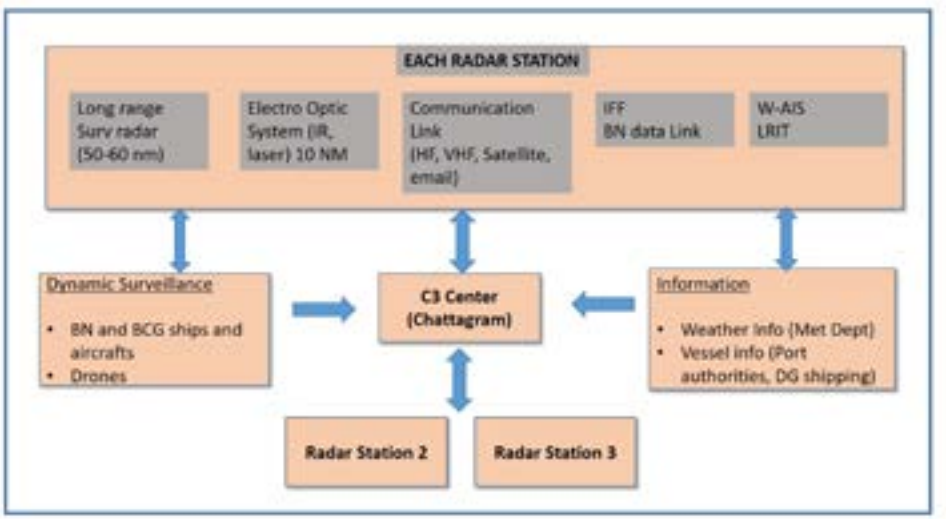


Figure 6 : Proposition for system composition of shore based surveillance network
(Source : Author's construct)

Establishment of Maritime Information Coordination Centre (MICC)

The evolving nature of non-traditional threats in 4IR and scope of exploiting technology by non-state actors demands collaboration among all maritime stakeholders. Taking lessons of Mumbai attack 2008, India established National Command Control Communication and Intelligence Network (NC3IN) incorporating relevant maritime agencies for coastal security. Thailand also established Maritime Enforcement Command Centre (MECC)

that acts as focal point for tackling Thailand's maritime insecurities bringing together Navy, Police and relevant maritime departments. Of late Pakistan has also established a Joint Maritime Information Center (JMICC). Taking those lessons, establishing maritime information coordination center is need of time. The purpose of this center will be to provide platform for exchanging information, enhance MDA and facilitate security agencies to respond to crisis together. Following is a simple overview of such center including surveillance network, integration of various information sources, probable agencies involved and broad system composition :



Figure 7 : Overview of Maritime Information Coordination Centre (MICC) for Bangladesh
(Source : Author's construct)

Install AI Processing Devices in Future BN Platforms

BN can be in possession of 'Big Data Base' if she can materialise other goals like EW library, google app, shore based radar network and integrate data from other stakeholders through Maritime Information Coordination Centre. If those preserved data can be shared with ships on patrol, then it will facilitate them to quickly identify and prosecute any intruders or unknown contacts. Therefore, a simple installation of AI processing devices on those ships connected with the 'Data Base' from shore could automatically analyse and provide informed decision to ship's command about detected target's classification.

Summarizing the Long Term Measures

The summary of short term measures are combined in the following table below:

Lead Resp	Govt	BN (through Govt Approval)	BN
	Establishment Maritime Information Coordination Centre	**Establish Military Grade Shore based Surveillance Network**	**Install AI devices in Future BN OPV platforms**
Effects	Provide platform for exchanging information, augment MDA through surveillance and facilitate security agencies to respond to crisis together	Enhance Surveillance over much bigger area, identifying unauthorized objects and defend coastal areas and infrastructures through early warning	Automatically analyse and provide informed decision to ship's command about detected target's classification

Table 2 : Summarisation of Long Term Measures
(Source : Author's construct)

Proposed Model to Redesign BN's Peacetime Operational Capability

The following model is a holistic proposal that synchronizes all the phase wise options mentioned above divided into short term (1-5 years) and long term (5-10 years). It includes all the relevant maritime stakeholders and intelligence agencies while mentioning Government's required support and approval to deliver a coordinated and synchronized effort to counter non-traditional threats at sea in today's 4IR environment.

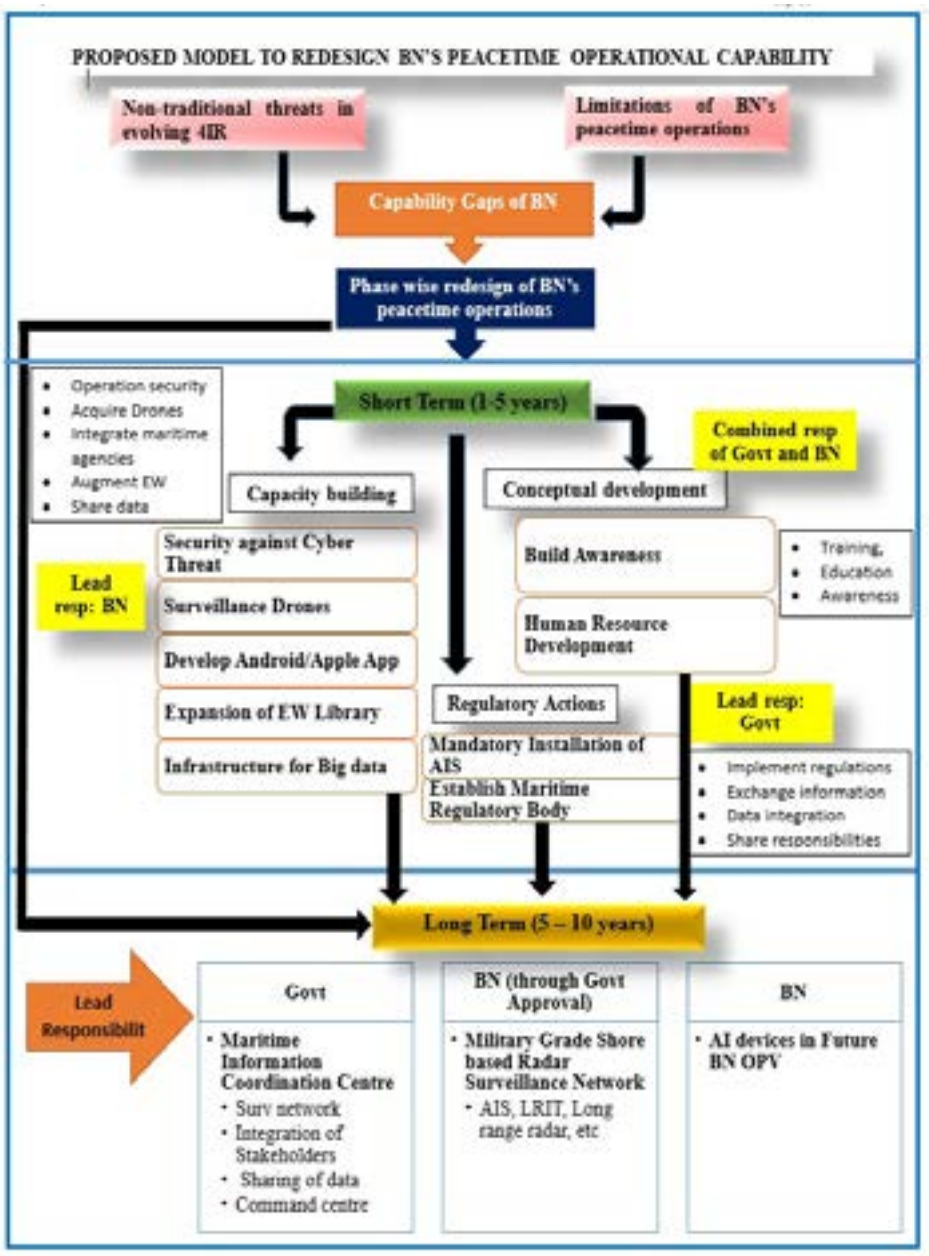


Figure 8 : Proposed Model to Redesign BN's peacetime operational capability.
(Source : Author's construct)

SWOT Analysis of the Prescribed Model

STRENGTHS	WEAKNESSES
• Elevates BN's operational effectiveness in 4IR against non-traditional threats • Enhances MDA in northern BoB • Integrates all Maritime security stakeholders under common umbrella • Sustainable framework if backed by government • Most of the proposed measures are synchronised with plan of Forces Goal. Additional budget requirement would be few	• Unfamiliarity on 4IR among senior leadership • Lack of general mindset to recognize it as an unavoidable feature of the current era • Challenge in mobilising maritime security stakeholders during forming stage of the fusion centre
OPPORTUNITIES	**THREATS**
• Provides scope to integrate with the regional fusion centres or the likes • Simultaneously improves warfighting capability against traditional threats • Enhanced cooperation amongst maritime stakeholders	• Interference from stronger neighbouring and regional countries • Resistance from vested corners to accept BN to lead Maritime information coordination Centre

Figure 9 : SWOT analysis of the proposed model.
(Source : Author's construct)

Addressing Weakness and Threats

Mobilizing the Maritime stakeholders

Currently, many stakeholders are pursuing individualistic approach in maritime domain. Besides, there is organizational tendency to catch the larger pie in any coordinated activities. Therefore, forming MICC could be challenge to bring all under common framework. To mitigate this, clear strategic directives and strong government back up is required to keep all the organizations in a common foothold.

Interference from Other Countries

Progression towards the achieving model could be interfered by vested interests of stronger neighbours and regional countries. They could grab

construction and installation of projects to create monopolization. Thereby, source of origin and the country should be so selected who have less conflicting interest with BD and is expected to provide critical support during crisis.

Resistance to accept BN to lead Maritime Information Coordination Center

While it is true that BN is the lead maritime security agency in BD, but many corners do not always agree. On the other hand, majority of task to form and set up the MICC would require BN's support. Therefore, deciding command and control and governing MICC may be kept open between ministry of Shipping and BN so that there is flexibility and harmonious civil military cooperation.

Capitalizing Strengths and Opportunities

Countering Traditional Threats

4IR could also give scope to the potential adversaries to exploit their gains. Therefore, if the proposed are implemented such as cyber defense, Drone acquisition, EW library, shore based surveillance network, installation of AI, etc, it will also **improve BN's warfighting capability facilitating to address traditional threats** in future.

Integration with Regional Partners

As 4IR is new to many states, therefore, capitalizing early on 4IR may leveraging diplomatic posture in regional environment. Besides, this will create scope with existing Regional Fusion Centres to integrate and deal transnational maritime threat through wider cooperation.

Conclusion

Today the world has entered the era of 4IR influencing all areas of our society, way of thinking and lifestyle. However, it has also become a security concern, as the non-state actors could exploit 4IR to their illicit gain. Likewise, it was identified that, there are scope for the non-state actors to exploit 4IR and proliferate non-traditional maritime threats at sea. Therefore, the problem was whether BN is prepared to deal changed form of non-traditional maritime threats

influenced by 4IR. As such, the paper studied to identify the shortfalls and then draw a road map for redesigning BN's peacetime operations.

The findings of 4IR's impact revealed disruption to maritime shipping through cyber-attack, rise to maritime terrorism, evolutions of piracy and armed robbery, illegal fishing with modern gadgets and use of superior technology by human traffickers etc. Then the study identified some limitations in BN's peacetime operational capabilities against cyber threat, primitive surveillance capability, gaps in coordination among the stakeholders, limited database to generate MDA and finally unfamiliarity with 4IR.

To address the problem, a phase wise approach divided in short term (1-5 years) and long term (5-10 years) was put forwarded. In short term, the proposals were categorized under capacity building, conceptual development and regulatory actions. Capacity building for BN included development infrastructure to ensure security against cyber threat, acquisition of surveillance drones, develop mobile software application, development of EW library and develop infrastructure and base for preserving "Big Data". Conceptual development included building awareness among maritime stakeholders and human resource development so that 4IR's security concerns are understood among BN and maritime stakeholders. The regulatory actions included mandatory installation of AIS and establishment of a maritime regulatory body to provide the maritime security stakeholders an authoritative framework to exchange information, share responsibility and coordinate activities to ensure maritime security.

In regards to long term, measures include construction of shore-based surveillance network to enhance MDA. Then establishment of Maritime Information Coordination Centre integrating relevant maritime agencies of Bangladesh was proposed. Such centre is expected to set the platform for exchanging information, augment MDA and enable security agencies to respond to crisis together. Another option was to install AI devices on board BN ships connected with data base which could automatically provide informed decision to command. Consolidating all, a holistic model was suggested to redesign BN's operational taking Government's support and approval. At the end SWOT

analysis of the model was carried out. To conclude, 4IR is now an unavoidable future. Therefore, embracing this revolution faster and incorporating its features soon will only help to counter non-traditional maritime threats in 4IR era.

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Biography of the Writer



Commander Abu Sadat Mahmud Safeer Chowdhury, (G), NPP, afwc, psc, BN was born in 07 February 1982 in Dhaka. He passed from Faujdarhat Cadet College and joined Bangladesh Navy as Officer Cadet. He was commissioned on 21 Dec 2002 as the best all-round midshipmen and was awarded "Sword of Honour". The officer featured outstanding results in numerous professional courses. He completed Surface Vessel Artillery Course in China, Long Gunnery Course from India, Junior Staff Course at BD Air Force, and Small Ship Command Course in UK etc. His academic qualification includes Bachelor in Science from National University, Masters in Defence Studies from Defence Services Command and Staff College and Post-Graduation in Defence Studies from National Defence University, Malaysia.

The officer served in various command, staff and instructional appointments. He twice served at Naval Academy as Instructor. He was appointed on board various ships as Gunnery Officer and Executive Officer. Besides, he served in 'Directorate General Forces Intelligence' and Armed Forces Division. The officer served under Blue Helmet at UNIFIL as Staff Officer at Force Headquarters in 2010-11. The officer commanded PCs and LPC namely BNS CHITRA, MEGHNA and NISHAN. At Naval Headquarters he served as Deputy Director Naval Operations. The officer completed Armed Forces War Course from NDC and currently pursuing for Masters of Philosophy in Security and Development under BUP. He was awarded for Nou Parodorshi Padak (NPP) for his outstanding service in 2022. At present, the officer is posted as Executive officer of BNS PROTTOY. He is happily married and blessed with two sons.

IMPROVING BANGLADESH NAVY HYDROGRAPHIC AND OCEANOGRAPHIC SERVICES TO SUPPORT THE NATIONAL BLUE ECONOMY

Commander Shaikh Imtiaz Bin Firoz, (H1), psc, BN

Abstract

The blue economy concept came to the discussion to meet the challenges of the 21st century. After the maritime boundary delimitation with neighboring countries, the Government of Bangladesh stated its interest in pursuing the blue economy concept. However, there are number of challenges on the way to adopt an effective blue economy concept. Bangladesh Navy (BN) is also performing their role to support the national blue economy. The fundamental intention of this paper was to analyze the present capabilities of BN, whether its development can enhance the capability to support national blue economy program of Bangladesh or not. It seems that if BN can improve its overall capability, it would support the national blue economy in a better way.

Introduction

The ocean of the world is essential to our planet's existence. This provides the largest source of protein for humans and absorbs about 25 percent of our carbon dioxide emissions as well as most of the extra heat in the world. The ocean also contains half of the oxygen in the planet. For their livelihoods, cultures and traditions, billions of people depend on it. The seabed currently provides extension of production for 32 percent of the global source of hydrocarbons. The sea also provides tremendous potential for the creation of sustainable "blue energy" from wind, water, tidal, thermal and biomass sources. According to the World Bank, the blue economy is the "Sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem″.

In Bangladesh, discussions on blue economy started after the settlement of maritime boundary delimitation dispute with Myanmar (2012) and India (2014). Proliferation of marine resources in this area offers scope to Bangladesh for

sustainable economic development, which needs an integrated maritime policy. Bangladesh Navy (BN) is responsible to acquire bathymetric and oceanographic information of the Exclusive Economic Zone (EEZ) as per the Rules of Business provided by the Government. With the existing hydrographic and oceanographic capabilities, BN can support the national blue economy activities. In that context BN started their journey of hydrographic survey with two survey crafts namely BNS TALLASHI and BNS DARSHAK in the year 1983 and successfully published the first chart in the same year. With the hard work by the hydrographers, BN could publish international and national charts for the whole coastal area and EEZ of the country. BN also started producing Electronic Navigational Chart (ENC) which is necessary for navigation.

The improvement of hydrographic and oceanographic capabilities of BN is now taking shape to support the national blue economy. There are many areas in the coast and EEZ where the hydrographic survey was not conducted by multibeam echo sounder which is very essential in modern days. Furthermore, the other capabilities like the efficiency of personnel, providing training, interoperability among the maritime agencies etc also require improvement. The existing BN hydrographic and oceanographic capabilities may support the national blue economy in a limited scale. However, there are scopes to improve the hydrographic and oceanographic capabilities of BN to support the national blue economy.

In this paper existing resources, capabilities and probable contribution of BN to support the national blue economy will be analysed. Thereafter, the existing challenges and ways out will be highlighted in this paper. However, the main analysis will be made for finding out the ways to improve the role of BN to support the national blue economy.

Aim

The aim of this paper is to highlight the ways to improve the hydrographic and oceanographic capabilities of BN to support the national blue economy.

Concepts of Blue Economy, Hydrography and Oceanography

Genesis of Blue Economy

The UN University (UNU) first conceptualized Blue Economy in 1994. A Belgian born economist and entrepreneur, Gunter Pauli, was invited by the University to establish a think tank with the objective of creating a new economic model that added jobs and value to society without increasing polluting waste, emissions or cost of investments. Interestingly, this initiative was seeded by the UNU almost three years prior to the Kyoto Protocol. Consequently, Pauli established the Zero Emissions Research and Initiatives (ZERI) in Switzerland. ZERI's focus was to move commerce and industry towards sustainability without subsidies and tax cuts. Finally, in 2010, ZERI came up with a proposal of 100 innovations and presented it in a Report to the Club of Rome titled The Blue Economy. Thus, ZERI could be considered as the cradle of Blue Economy.

Importance of Hydrography and Oceanography to Support the Blue Economy

Hydrography is hardly mentioned in the everyday parlance of the public. Furthermore, it is neither discussed nor regarded as a pressing national issue. However, hydrography is an essential tool for different ocean activities, livelihoods and revenue earnings. In addition to maritime safety, hydrography gives sustenance to the blue economy, involving activities such as: energy, maritime transport, telecommunications, tourism, fishing, meteorology, among others. To emphasize the importance of the blue economy, the theme for the World Hydrography Day 2013 was "Hydrography - Underpinning the Blue Economy". In 2018 the theme was selected as "Bathymetry - the foundation for sustainable seas, oceans and waterways". These two self-explanatory sentences speak about the importance of hydrography and oceanography in support of blue economy more specifically for a sustainable blue economy. If hydrography and oceanography do not function, then vessels do not get to their destination or environmental data gathering is not happened. Some of the aspects of the blue economy where hydrography and oceanography functions are :

a. Nautical Charting (Navigation).

b. Port and Harbor Maintenance (Dredging).

c. Coastal Engineering (Engineering and Modeling).

d. Coastal Zone Management (Coastal and Marine Governance).

e. Offshore Resource Management, Development and Exploitation (Economic Activities).

f. Weather Forecast.

g. Climate Change Research.

Blue Economy Concept of Bangladesh

Presently, the Blue Economy has no consistent concept throughout the world. It is now comprehended in different ways by different countries and different organizations. They are defining blue economy as development philosophy, economic policy, strategic framework or the extension of marine economy. Blue Economy in Bangladesh is about sustainable economic development, considering advantages and strategies of managing the resources of blue ocean, where economy grows and people prosper, ensuring the carrying capacity of blue ocean. It is evident that blue economy demands a balance of conservation, utilization and exploitation. After the maritime boundary delimitation with neighboring countries in 2014, the Government of Bangladesh stated its interest in pursuing the blue economy concept as part of the country's growth strategy.



Figure 1 : Maritime Area of Bangladesh

(Source : Collected from https://demaribus.net/2014/07/08/pca-award-bay-of-bengal-maritime-boundary-arbitration-bangladesh India/)

Present Capabilities and Recent Developments of BN

Present Capabilities of BN

A Blue Economy Cell was established in NHQ on 07 February 2017 to coordinate matters with different ministries and agencies. Later a Blue Economy Directorate (Adhoc) was established in NHQ under Assistant Chief of Naval Staff (Operations) who is also performing the duties of Chairman of National Hydrographic Committee (NHC).

Hydrographic Office/ Services. Bangladesh Navy Hydrographic Department (BNHD) is vested with the responsibility of hydrographic survey in the coastal and offshore area of Bangladesh. Besides, Bangladesh Inland Water Transport Authority (BIWTA) conducts surveys for inland waters. The BNHD consists of a fleet of five survey ships and craft, Bangladesh Navy Hydrographic and Oceanographic Center (BNHOC) and BN Hydrographic School. The Directorate of Hydrography at the Naval Headquarters is the national representative of Bangladesh to International Hydrographic Organization (IHO) and exercise functional authority over BNHD. All the hydrographic activities of the country are coordinated through the National Hydrographic Committee (NHC). NHC addresses the hydrographic and other related activities at the national level. Different ministries and stakeholders are the members of NHC. The Assistant Chief of Naval Staff (Operations) of BN is the Chairman of that Committee.



Figure 2 : BNHOC at Chattogram

Hydrographic and Oceanographic Surveys. BNHD carries out survey operations with the help of her survey fleet which comprises of a purpose-built deep-sea survey vessel namely BNS ANUSHANDHAN, two offshore survey vessels namely BNS SHAIBAL and BNS SUROVI and two coastal survey crafts namely BNS TALLASHI and BNS DARSHAK. BN also has two specialized survey boats in her inventory. All these ships/craft are fitted with modern hydrographic equipment for carrying out effective survey operations.



Figure 3 : BN Hydrographic Fleet

Survey Activities. BN survey fleet carries out hydrographic survey operations every year as per the annual survey programme. BN Chief Hydrographer in consultation with Hydrography Directorate in Naval Headquarters promulgates annual survey programme considering national maritime interest pertaining to navigational safety. Due to the dynamic nature of coastal area, BNHD must continue regular updating of national and international series charts to ensure safe navigation. Not only that, BNHD also carries out a good number of survey activities considering the requirement placed to BN Chief Hydrographer.

Oceanographic Activities. After the settlement of the maritime boundary with neighbours, Bangladesh has given special emphasis on oceanographic research activities. Bangladesh Government is planning to acquire an Oceanographic Research Vessel. BN Officers are also undergoing higher study on Oceanography in various institutions of Bangladesh including Bangabandhu Sheikh Mujibur Rahman Maritime University, Dhaka University, etc. Since other Bangladeshi universities and research organizations are not capable to proceed to sea due to unavailability of vessels, BN helps with suitable platforms. BNHD always remains supportive to oceanographic researchers to ensure that they get maximum opportunity to carry out research activities for acquiring better knowledge about the marine environment.

Bangladesh Navy Hydrographic and Oceanographic Centre (BNHOC)

BN Chart Depot was established in 1983. After modernization of the hydrography department, the responsibility and sector of hydrographic survey increased manifold. But BN Hydrographic Department did not have a full-fledged organization to monitor the survey works, data processing, cartographic works, storing of data, circulation and in general a research institute. The necessity was felt to establish a center as the hub of all hydrographic activities of BN. To perform all those tasks BNHOC was established in the year of 2001 and BN Chart Depot was merged with that center. With the enhanced capability of international standard hydrographic survey, BN brought home the prestigious membership of International Hydrographic Organization (IHO) in 2001. Subsequently BN were entrusted by IHO with 09 international charts. BNHOC has already published 49 national charts and 11 ENC of all the major seaports, rivers and EEZ areas of Bangladesh.

BN Hydrographic School

BN Hydrographic School was established in 1983. From the very beginning the school has conducted various courses. The Basic Hydrographic Course conducted by BN Hydrographic School is recognized by **the International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers** (IBSC) as Cat ‘B’. Apart from BN officers and sailors,

BN Hydrographic School also provides training to IHO member states trainees as well as personnel from non-military survey agencies of the country.

Recent Developments of BN

Different equipment and technologies used for Hydrographic and oceanographic survey are changing and modernizing day by day. To cope with the challenges of 21st century BN is also developing herself. Few of the ongoing projects are appended below :

a. **BN Chief Hydrographer.** The post of BN Chief Hydrographer in a rank of Commodore has been already approved by the Government of Bangladesh. All the hydrographic and oceanographic activities of BN were conducted under his supervision. Close coordination with the Government agencies, departments, institutions and ministries will be needed in this regard.

b. **Survey Vessels.** 02 in number catamaran type Hydrographic Survey Vessels and 02 in number Survey Boats constructed at Khulna Shipyard Limited, which are already in operation. These vessels/boats are equipped with MBES and other state of modern hydrographic survey equipment's.

c. **New Technologies and Equipment's.** Incorporation of new technologies and equipment is a continuous process. BN is also in progress of acquiring following equipment in recent years :

(1) Shallow Water Multibeam Echo Sounder.

(2) Side Scan Sonar.

(3) Single Beam Echo Sounder.

(4) Auto Tide Gauge.

(5) Total Station.

(6) Various Hydrographic and Cartographic Software.

(7) Acoustic Doppler Current Profiler.

Limitations of BN to Support National Blue Economy

Limitations of BN

Since the inception BN has developed a lot. Initially the work process was not digital, and the survey work was time consuming. Presently all the survey work is being carried out digitally. But the technologies and equipment's are also upgrading very fast. Few of them are mentioned below :

a. **Shortage of Skilled Manpower.** Shortage of skilled manpower has become a burning issue for BN. Most of the ships and establishments of BN are directly suffering from skilled manpower. To meet the challenges of the 21st century and to keep pace with world hydrographic and oceanographic trends, personnel of BN need proper and modern training. Though BN has a good number of officers and sailors, most of them remain out of departmental jobs for long times. The most skilled personnel are picked up by NHQ and some other organizations for their communal or deputation duties. Even, when they are appointed/ drafted in any hydrographic ship or organization they are performing temporary (Ty) duties in different bases, forward bases and projects.

b. **Shortage of Purpose-Built Hydrographic Ships.** BN has a total of 5 hydrographic ships. Amongst them only BNS ANUSHANDHAN and two newly built catamaran type vessels are purpose built hydrographic ships. Besides these two modified mine sweepers comprising BN hydrographic survey fleet. Most of the equipment's are portable while there are no modern survey boats onboard except BNS DARSHAK and BNS TALLASHI. BN remains committed throughout the year for military hydrography and oceanographic data collection. She does not have equipment to conduct biological and chemical oceanographic data collection. Though BNS ANUSHANDHAN has water sampler by winch it can collect water sample up to 1200 meters depth, it does not have dry and wet laboratory onboard to test the samples.

c. **Shortage of Modern Survey Equipment.** The technologies of hydrographic and oceanographic survey are very fast moving. New technologies and equipment are paramount for modern survey. Previously BN only used to conduct surveys and produce paper nautical charts. To meet the challenges of 21st century and for sustainable development by supporting national blue economy program continuous upgradation of equipment and technologies are required. Incorporation of shallow water multi beam echo sounder, Remotely Operated Underwater Vehicle (ROV), Autonomous Underwater Vehicle (AUV), different types of oceanographic sampler are felt necessary.

d. **Absence of ORV.** BN conducts hydrographic survey to fulfill the national requirement. For harnessing the resources of our sea in an efficient manner, we need to have detail information of the ocean, sea floor, sub soil and whatever there on and above. To extract the utmost benefit of the ocean, knowing the ocean has no alternative. Therefore, the requirement of Oceanographic Research Vessel (ORV) is felt by the maritime community. However, Bangladesh has very limited oceanographic research capability. Due to the economic constraint, skilled manpower, lack of high-tech instrument and platforms the country is far lacking behind of carrying out oceanographic research and quantifying and extracting of much needed resources from sea. BN has the capabilities to cooperate with other oceanographic organizations to improve the existing oceanographic capabilities of Bangladesh by utilizing its organization, manpower, knowledge and experience of the ocean.

e. **Absence of Oceanographic Lab.** BN does not have any oceanographic lab facilities. Though the survey ships can collect limited amount of oceanographic data, BN doesn't have any capabilities to store, examine and research with them. Sometimes collected soil samples were sent to the Department of Soil Science or Institute of Marine Sciences of Chittagong University for testing. Before establishing any coastal structure, BN is frequently asked to provide certain oceanographic, geological and meteorological data. To derive maximum benefit from the national blue economy program the establishment of a fully equipped oceanographic

laboratory in BNHOC has become very important. After insertion of submarine in BN fleet, the requirement has increased a lot. Along with space and equipment a certain number of trained personnel is also needed for the proper use of the labs. A full facilitated oceanographic database is also needed to store the data for future use.

Improving Capabilities of BN to Support National Blue Economy

General

From the study, it is well understood that the BN has the capabilities to support national Blue Economy through the skilled manpower, while utilizing knowledge, platform and sensor/gears/facilities. There is no hesitation that if BN can improve her overall capability, it would support National Blue Economy in better way.

Creating More Skilled Manpower

As skilled manpower is the prerequisite to develop any sector, BN needs to give emphasis to development of skill of her personnel. To meet the challenges of 21st century and to keep pace with world hydrographic and oceanographic trends, personnel of BN need proper and modern training. However, emphasis can be given on following points :

a. **Increasing Training Facilities.** The area and the dimension of BN hydrographic and oceanographic survey in BoB has increased many folds. Which demand more manpower with sufficient skill to handle the added responsibilities and future challenges. Modern training facilities with required infrastructure may help creating required skilled manpower. Increasing the capabilities/ training facilities of BN Hydrographic School may help to create more skilled manpower.

b. **Requirement Based Training.** Ocean research is a complex matter and with the advent of new technologies it will be more complex in future. This trend suggests a greater need for a technically skilled workforce both for academic research and support as well as implementation of monitoring

and observations. BN is responsible to make professional hydrographers, cartographers and some of them may be sent to CU/DU for Master's in Oceanography study and Bangladesh Meteorological Department/ Bangladesh Air Force/ Department of Meteorology in DU.

c. **Appointing Personnel in Related Field.** BN has a handsome number of officers and sailors. Emphasis may be given to drafting/ appointing them in respected departmental jobs. Skilled personnel must not be in communal or deputation duties for a long time. When they are appointed/ drafted in any hydrographic ship or organization, they shouldn't be sent for Temporary (Ty) duties which are communal in nature.

Keep Pace with Technology

Now a days hydrographic and oceanographic surveys are totally dependent on modern sensors and equipment to meet the IHO standard. At present BN has a good number of gears, equipment and sensors to conduct IHO standard hydrographic survey. But in terms of oceanographic survey capability of BN is quite limited. At the same time a few gears and equipment are age-old or nonoperational. Continuous upgradation of equipment and technologies is required to keep pace with demand. Incorporation of shallow water multi beam echo sounder, Remotely Operated underwater vehicle (ROV), Autonomous Underwater Vehicle (AUV), different types of oceanographic sampler can give a big boost.

Acquire Oceanographic Research Vessel

The main hindrance to the oceanographic research in Bangladesh is the non-availability of oceanographic research vessel. Until now, BN has provided limited support to other organizations working in the field of oceanography. However, considering the vastness of research activities for exploration and exploitation of maritime areas of Bangladesh this assistance is bare minimum, and it is necessary to have at least one or two oceanographic research vessels for the greater interest of the nation.

Building better Cooperation with other Agencies

There are numbers of agencies working directly and indirectly to work with ocean data of BoB, like BN, Chattogram Port Authority, Payra Port Authority, Mongla Port Authority, SPARRSO (Space Research and Remote Sensing Organization), BMD (Bangladesh Metrological Department), different universities, GSB (Geological Survey of Bangladesh) and many more. Resource sharing, data sharing and knowledge sharing among the agencies would enhance the overall ocean survey capability of Bangladesh. A governing body under the Prime Minister's Office like National Maritime Division and a post like Chief Hydrographer to the Government would help build better cooperation among the agencies.

Establishment of Oceanographic Lab

An oceanographic lab under BNHOC will enable storage, examine and research with collected oceanographic data to derive best use of it. To obtain maximum benefit from the national blue economy program, the establishment of a fully equipped oceanographic laboratory in BNHOC has become very important. An ocean lab with trained personnel and a fully facilitated oceanographic database will enhance the capabilities of BN a lot.

Creating R & D Cell

Hydrographic and Oceanographic survey is conducted based on standard theories, knowledge, sensors, gears and of course by skilled workforce. Research and Development (R & D) cell would help finding out the grey areas, limitations, errors, difficulties as well as the effective solution thereof. Besides these lots of coastal mega projects are going on like deep seaport, LNG terminal, Matarbari Power Plant, etc. Their shot term and long-term effect on our coastal area and overall blue economy needs meticulous study. Hence creating an R & D cell for BN would improve her critical survey capability. Effective support from Bangladesh Oceanographic Research Institute (BORI) would help R & D activities of BN.

Conclusions and Recommendations

Conclusions

After the maritime boundary delimitation with the two neighbouring countries when a general consciousness is growing about the ocean and its economic use, at that time the research paper "Development of BN Hydrographic and Oceanographic Capabilities to Support National Blue Economy" aimed to identify the present capabilities and limitations of BN to support national blue economy program and find out the scopes of development for BN.

The BoB have always played a key role throughout the history of Bangladesh. It is an area full of resources both for living and nonliving. It is also a great source of potential hydrocarbons. The livelihood of coastal people and country's overall economy is highly dependent upon the sea. With the effects of climate change, rising sea level and salinity are two big concerns to the coastal population. The monsoon and the oceanic weather have a profound influence on the activities on land. Thus, increasing the working capabilities of hydrography and oceanography is essential for Bangladesh.

After analyzing the capabilities of BN, it is found that BN has medium capabilities in hydrographic and limited capabilities in oceanographic survey. It has five survey vessel, world standard training school, skilled manpower and good amount of survey gears and equipment. The study identified that BN is providing necessary chart, tidal table, notices to mariners and other publication to international shipping. BN may help in Integrated Coastal Zone Management for subsequent coastal economic development. It may also support concerned agencies by providing critical oceanographic, metrological and seabed data for maritime security and research work. These all are eventually supporting Blue Economic aspiration of Bangladesh. Thus, BN may be a potential part to support the national Blue Economy which demands attention of due concerned authorities.

To meet the challenges of the 21st century and to support the national blue economy program BN needs to overcome her limitations. However, the likely challenges of BN to support blue economy program are shortage of

skilled manpower, shortage of purpose build hydrographic ships, absence of oceanographic research vessel, absence of ocean lab and coordination with other agencies. Skilled manpower with modern equipment and purpose-built ships.

All most 17 ministries and many agencies are working for Blue Economy aspiration. Making bridges amongst the agencies and getting expected cooperation is a serious issue. A governing body under the Prime Minister's Office like National Maritime Division and a post like Chief Hydrographer to the Government would help build better cooperation among the agencies. As a leading maritime agency, BN should take an active role in the National Blue Economic cell to ensure fruitful engagement of BN in National Blue Economic activities. BN may take an active role to enhance the overall capability of BN through bilateral and international support. Such support may focus to facilitate BN to engage in National Blue Economic endeavor in much professional way.

Recommendations

BN has huge potential to support National Blue Economic initiative. Hydrography and Oceanography are multidisciplinary subjects; hence capabilities may be enhanced through resource and expertise sharing among the agencies. Sustainable development in hydrographic and oceanographic sectors may require international cooperation. In seeking such endeavor for capacity building of BN and enhance cooperation at all levels following recommendations are made :

a. NHQ may take a leading role to formulate National Maritime Division (NMD) at the earliest which may work directly under the Prime Minister's Office and will be headed by Chief Hydrographer to Government (Rear Admiral of BN).

b. NHQ may take the necessary step to acquire one well equipped and purpose-built Oceanographic Research Vessel (ORV) for BN within a short period to meet the future challenge of National Blue Economy aspiration.

c. NHQ may take the necessary step to establish an oceanographic lab and R & D cell under BNHOC.

Biography of the Writer



Commander Shaikh Imtiaz Bin Firoz, (H1), psc, BN joined Bangladesh Navy on 01 January 2004 with 2004-A batch and was commissioned on 01 December 2005 in Executive Branch from Bangladesh Naval Academy (BNA). He studied in Mirzapur Cadet College which is a military school and college. The officer attended number of courses in home and abroad. He did Officers Weapon Course from School of Infantry and Tactics, Basic Hydrographic 'CAT B' Course from BNS ISSA KHAN, Potential Platoon Commanders Course from Bangladesh Military Academy and Junior Staff Course from BNA. He did a training onboard French ship 'Beautemps Beaupress' and Long Hydrographic 'CAT A' and Masters in Hydrographic Science from University of Southern Mississippi, USA. He is also a graduate from DSCSC, Mirpur and DSCSC Sri Lanka. He served onboard different ships of Bangladesh Navy in different capacities like – Commanding Officer of BNS SUROVI and BNS AGRADOOT, Executive Officer of BNS ANUSHANDHAN and other appointments. He served as Staff Officer in Training Directorate and Hydrographic Directorate at Naval Headquarters. He performed instructional duties in BNA and BN Hydrographic School. He participated in UN Peacekeeping Mission in DR Congo as Military GIS Officer. He is happily married and blessed with one son. At present he is serving as Deputy Director of Hydrography at Naval Headquarters.

NAVIGATING THE DIGITAL SEAS : ASSESSING VULNERABILITIES OF BANGLADESH NAVY TO CYBER-ATTACKS

Lieutenant Commander Sk. Mahmud Hasan, (G), BCGM, psc, BN

Abstract

As digitalization permeates the operational landscape of the Bangladesh Navy, the vulnerability to cyber-attacks emerges as a critical concern. This paper presents a comprehensive assessment of the potential vulnerabilities within the Bangladesh Navy's digital infrastructure, emphasizing the need for a robust cyber-security framework. Through a systematic analysis of the current digital architecture and an exploration of potential threat vectors, this study identifies key weaknesses that expose the Navy to cyber-attacks. Drawing upon both qualitative and quantitative data, the research underscores the pressing need for tailored cyber-security protocols, training programs, and technological fortifications to safeguard sensitive naval operations from malicious cyber threats. By examining the interplay between technological advancements and security measures, this study contributes to the discourse on the imperative integration of cyber-security strategies in the maritime defense infrastructure. The findings underscore the necessity of proactive measures to fortify the digital resilience of Bangladesh Navy and ensure the integrity of its critical operations in the digital era.

Introduction

Cyber threats have evolved significantly over the years, becoming more complex, targeted, and persistent. What once may have been perceived as basic viruses and malware have transformed into sophisticated cybercrime operations, encompassing various forms of attacks such as phishing, ransom ware, and distributed denial-of-service (DDoS) attacks (Cooney, 2020). In an era defined by the interconnectivity of global networks and the growing reliance on digital infrastructure, the significance of cyber-security cannot be overstated, especially in the context of maritime security and defense. Bangladesh Navy, a vital component of the nation's defense apparatus, relies heavily on digital systems

and technology to ensure the safety of its maritime borders, maintain operational efficiency, and safeguard critical national interests.

Bangladesh Navy has realized how crucial it is to strengthen its cyber-security infrastructure in order to protect its digital assets and uphold maritime sovereignty in a period of unprecedented technological growth. Understanding the evolving landscape of cyber threats, the Bangladesh Navy has embarked on a comprehensive journey to fortify its defenses and foster a culture of cyber resilience. Through a series of initiatives and technological advancements, Bangladesh Navy is poised to establish a robust digital naval shield, ensuring the security and integrity of its operations in the digital age.

In this article, firstly, the types of cyber threats that BN may face will be discussed. Thereafter, the present capacity of the BN will be discussed, along with a few challenges. This article will conclude by highlighting a few steps to improve its cyber-security capabilities.

The Evolving Landscape of Cyber Threats in the Maritime Domain

In an era defined by interconnected digital networks, the maritime industry has witnessed an unprecedented integration of technology into its operations. However, this rapid digitalization has also exposed the maritime domain to a plethora of cyber threats, underscoring the critical need for robust security measures. From sophisticated ransomware attacks to targeted system intrusions, the spectrum of cyber threats faced by the maritime sector is vast and multifaceted. Understanding these threats and implementing comprehensive security protocols is imperative to safeguard the integrity of global maritime operations (Edward, 2009).

The maritime industry, encompassing shipping, ports, and offshore operations, has become increasingly reliant on digital technologies for efficient and streamlined operations. However, this reliance has made it susceptible to an array of cyber threats that can disrupt vital operations and compromise the safety of ships, cargo, and port facilities. Some of the most prevalent cyber threats in the maritime domain include (Iftekhar, 2022) :

a. **Phishing and Social Engineering Attacks.** Cybercriminals often exploit human vulnerabilities through deceptive emails and social engineering techniques, leading to unauthorized access to sensitive data and systems.

b. **Ransomware Attacks.** Malicious software designed to block access to a computer system or data until a ransom is paid poses a significant threat to maritime operations, potentially leading to operational disruptions and financial losses.

c. **Data Breaches and Information Theft.** Unauthorized access to sensitive information, including cargo manifests, port logistics and vessel routes, not only compromises commercial interests but also poses a threat to national security.

d. **Operational Technology (OT) Intrusions.** The integration of operational technology systems within the maritime sector has opened avenues for cyber-attacks targeting critical components, including propulsion systems, navigation equipment, and communication networks, potentially leading to disastrous consequences.

e. **Supply Chain Vulnerabilities.** The interconnected nature of the maritime supply chain renders it susceptible to cyber-attacks at various touch-points, including ports, shipping companies, and logistics providers, leading to disruptions and delays in global trade.

The Significance of Cyber-security for Naval Operations

In the modern era, naval operations have become increasingly reliant on sophisticated digital systems, making cyber-security a critical aspect of maintaining national security and safeguarding maritime interests. As the world becomes more interconnected, the threat landscape for maritime nations has expanded to include not only traditional physical threats but also those in the virtual realm. The significance of cyber-security for naval operations cannot be overstated, as it directly impacts the effectiveness, safety, and integrity of a nation's maritime capabilities (Haque, 2020) :

a. **Protection of Sensitive Information.** Naval operations often involve the transmission and storage of sensitive information, including operational plans, troop movements, and classified data. Cyber-security measures are crucial in protecting this information from unauthorized access, interception, or manipulation by hostile actors. Robust encryption, secure communication channels, and strict access controls are integral components of safeguarding sensitive naval information from falling into the wrong hands.

b. **Maintenance of Operational Integrity.** In the digital age, the integrity of a nation's naval operations is contingent on the secure and uninterrupted functioning of its digital infrastructure. Any unauthorized interference or disruption in communication systems, navigation controls, or command mechanisms can have severe consequences, potentially compromising the safety of personnel and the success of critical missions. By implementing robust cyber-security protocols, naval forces can ensure the resilience and continuity of their operations, even in the face of malicious cyber threats.

c. **Prevention of Unauthorized Access and Control.** The protection of naval assets, including warships, submarines, and maritime installations, is paramount to maintaining maritime superiority and defending national interests. Cyber-security measures play a vital role in preventing unauthorized access to these assets, thereby thwarting attempts by malicious entities to gain control or manipulate critical systems. By implementing stringent access controls, multifactor authentication, and real-time monitoring, naval forces can prevent unauthorized individuals or entities from gaining control of vital maritime resources, thereby enhancing overall security.

d. **Adherence to National and International Regulations.** In addition to protecting sensitive information and assets, adherence to cyber-security protocols is often a requirement mandated by national and international regulatory bodies. Many maritime conventions and agreements emphasize the importance of cyber-security in maintaining the safety and security of global maritime trade and navigation. By upholding these standards, naval forces not only ensure their own operational efficiency but also contribute to the overall stability and security of the international maritime domain.

Bangladesh Navy's Present Cyber-security Capability

In an era where digital threats loom large, the Bangladesh Navy has taken significant strides to bolster its cyber-security capabilities, reflecting its commitment to safeguarding its maritime interests in the face of evolving cyber risks. With a comprehensive approach that encompasses advanced technological infrastructure, specialized training programs, and strategic partnerships, the Bangladesh Navy has demonstrated a strong commitment to fortifying its cyber defenses and ensuring the security of its digital assets :

a. **State-of-the-Art Cyber-security Infrastructure.** The Bangladesh Navy's present cyber-security capability is anchored in state-of-the-art infrastructure that encompasses reliable software solutions, robust hardware systems, and cutting-edge cyber-security tools. The deployment of sophisticated firewalls, intrusion detection systems, and secure data encryption protocols has significantly enhanced the Navy's ability to detect and thwart potential cyber threats, ensuring the integrity and confidentiality of its sensitive digital information.

b. **Specialized Training Programs.** Recognizing that cyber-security is as much a human endeavor as it is a technological one, the Bangladesh Navy has invested in specialized training programs to equip its personnel with the necessary skills and knowledge to identify and respond to cyber threats effectively. However, there are still rooms to integrate comprehensive training modules that focus on cyber-security best practices, threat identification, and incident response protocols.

c. **Partnerships and Collaborations.** The Bangladesh Navy's present cyber security capability is further reinforced by partnerships and collaborations with leading cyber-security agencies and organizations. By fostering alliances with renowned cyber-security experts and institutions, the Navy has gained access to cutting-edge technologies, and threat intelligence. These partnerships have not only enhanced the Navy's technological capabilities but have also facilitated knowledge exchange and capacity building, enabling the Navy to stay abreast of the latest cyber-security trends and developments. However,

BN still lacks in strategic partnership to gain advanced technologies, and threat intelligence.

d. **Future Expansion and Innovation.** While the Bangladesh Navy's present cyber-security capability reflects its proactive approach to addressing digital risks, the institution continues to prioritize further expansion and innovation in its cyber-security endeavors. With a focus on continuous research and development, the Navy aims to stay at the forefront of emerging cyber-security technologies and trends, ensuring that its cyber-security infrastructure remains resilient and adaptive to the evolving nature of cyber threats.

Vulnerabilities and Challenges of Bangladesh Navy in the Cyber Domain

The Bangladesh Navy's susceptibility to cyber-attacks is now a pressing concern because modern naval operations depend heavily on digital communication. With an increasing reliance on interconnected systems, the Navy faces a myriad of potential vulnerabilities that can be exploited by malicious actors, posing significant risks to national security, operational efficiency, and the integrity of sensitive data. Understanding these vulnerabilities and challenges is paramount in formulating robust cyber-security strategies and fortifying the digital defenses of the Bangladesh Navy against emerging cyber threats in the maritime domain (Gillis, 2020) :

a. **Legacy Systems and Outdated Software.** The use of legacy systems and outdated software poses a significant vulnerability for the Bangladesh Navy, as these systems may lack the necessary security updates and patches to defend against modern cyber threats. Vulnerabilities within legacy systems can be exploited by cyber attackers to gain unauthorized access, manipulate data, and disrupt critical operations, highlighting the urgent need for the Navy to modernize its digital infrastructure and prioritize the implementation of up-to-date cyber-security measures to mitigate potential risks.

b. **Sophisticated Cyber Threat Landscape.** One of the foremost challenges confronting the Bangladesh Navy in the realm of cyber-security is the ever-evolving and sophisticated cyber threat landscape. The emergence

of advanced persistent threats (APTs), malware, and ransomware poses a significant risk to the Navy's digital infrastructure, requiring constant vigilance and adaptive defense mechanisms to mitigate the impact of potential cyber-attacks (Iftekhar, 2022).

c. **Human Factor Vulnerabilities.** While technology forms the backbone of cyber-security, the human factor remains a significant vulnerability in the Bangladesh Navy's efforts to uphold robust cyber-security practices. Inadequate awareness among personnel, lapses in adherence to cyber-security protocols, and the risk of social engineering attacks underscore the critical importance of comprehensive training programs and awareness campaigns to instill a culture of cyber-security vigilance at every level of the Navy's workforce.

d. **Insufficient Incident Response Capabilities.** Inadequate incident response capabilities can leave the Bangladesh Navy vulnerable to prolonged cyber-attacks, as a delayed or ineffective response to security breaches can exacerbate the impact of the attack and compromise the integrity of critical digital assets. Without a robust incident response framework that encompasses real-time threat monitoring, rapid containment protocols, and comprehensive recovery strategies, the Navy may face significant challenges in minimizing the damage caused by cyber incidents and restoring the operational continuity of its maritime activities.

e. **Lack of Comprehensive Cyber-security Training.** A lack of comprehensive cyber-security training among naval personnel presents a critical vulnerability, as human error and inadequate awareness can inadvertently create opportunities for cyber-attacks to penetrate the navy's digital defenses (Rahman, 2021). Without a thorough understanding of cyber-security best practices, threat detection protocols, and incident response procedures, naval personnel may unknowingly fall prey to social engineering tactics and phishing scams, compromising the security of sensitive information and opening avenues for cyber adversaries to exploit vulnerabilities within the Navy's digital ecosystem.

Figure 1: Phishing campaign against military organization of Bangladesh

Organization	Original Domain	Phishing URL/Domain
Bangladesh Armed Forces	mail.afd.gov.bd	mailafd-govbd-signin-true. *.com
Bangladesh Navy	mail.navy.mil.bd	mail-navy-mil-bd-loginhjdh. *
Bangladesh Defense Command and Staff College	mail.dscsc.mil.bd	mail-dscsc-mil-bd. *.app
Bangladesh Air Force	mail.baf.mil.bd	https://*.github.io/mail.baf.mil.bd /index.html
Rapid Action Batallion	www.rab.gov.bd	rab-gov-bd.gq

Source : Bangladesh Cyber Threat Landscape 2022

f. **Complex Supply Chain Networks.** The complexity of supply chain networks within the Bangladesh Navy's digital ecosystem introduces additional vulnerabilities, as third-party vendors and suppliers may inadvertently introduce malicious software or compromised components into the Navy's digital infrastructure. Supply chain attacks can undermine the integrity of critical systems, compromise the confidentiality of sensitive data, and disrupt the seamless flow of naval operations, underscoring the need for stringent supply chain security protocols and thorough vetting procedures to mitigate potential risks posed by external entities (CSIT, 2021).

g. **Lack of Comprehensive Regulatory Frameworks.** The absence of comprehensive regulatory frameworks tailored to the specific cyber-security needs of the Bangladesh Navy further exacerbates vulnerabilities, as the lack of standardized guidelines and protocols may leave the Navy susceptible to gaps in cyber-security compliance and governance. A comprehensive regulatory framework that addresses cyber-security standards, data protection requirements,

and incident reporting protocols is crucial in establishing a unified approach to cyber-security within the Navy, enhancing its resilience against potential cyber-attacks and fostering a culture of proactive cyber-security awareness among all stakeholders.

h. **Resource Constraints and Budgetary Limitations.** Limited resources and budgetary constraints pose substantial challenges for the Bangladesh Navy in its pursuit of comprehensive cyber-security measures. The acquisition of cutting-edge cyber-security technologies, the implementation of advanced threat detection systems, and the deployment of skilled cyber-security professionals demand significant financial investments, which may strain the Navy's existing budget and resource allocations.

j. **International Cyber-security Cooperation and Information Sharing.** As cyber security threats transcend national borders, the Bangladesh Navy faces challenges in fostering effective international cyber-security cooperation and information sharing with its global counterparts. Establishing robust partnerships, sharing threat intelligence, and collaborating on cyber-security best practices are essential components in the Navy's efforts to stay ahead of emerging cyber threats and ensure the security of its maritime operations in the context of the broader international maritime domain.

Ways Forward in Enhancing Cyber-security for the Bangladesh Navy

To bolster its cyber-security capabilities, the Bangladesh Navy can adopt a range of proactive strategies and best practices aimed at fortifying its digital infrastructure and enhancing its resilience in the face of emerging cyber risks :

a. **Investment in Advanced Cyber-security Technologies.** A critical step in enhancing cyber-security for the Bangladesh Navy involves the strategic investment in advanced cyber-security technologies and solutions. The acquisition of state-of-the-art firewalls, intrusion detection systems, establishment of advanced IT infrastructure and advanced threat intelligence

platforms can significantly bolster the Navy's ability to detect, mitigate, and respond to potential cyber threats, ensuring the integrity and security of its digital networks and sensitive information.

b. **Comprehensive Cyber-security Training and Education** Empowering naval personnel with comprehensive cyber-security training and education is essential in building a cyber-security-conscious culture within the Bangladesh Navy. Implementing specialized training programs that emphasize best practices, threat awareness, and incident response protocols can equip personnel with the necessary skills and knowledge to identify and address cyber threats effectively, thereby strengthening the Navy's overall cyber-security posture (Iftekhar, 2022).

c. **Establishment of a Cyber Command Centre.** Creating a dedicated cyber command centre within the Bangladesh Navy can streamline cyber-security operations and facilitate a proactive approach to managing digital risks. This command centre, comprising skilled cyber-security professionals and experts, can be entrusted with the responsibility of continuous monitoring, threat analysis, and the formulation of cyber-security strategies tailored to the specific needs and challenges of the Navy's digital infrastructure.

d. **Cyber Threat Intelligence and Information Sharing.** Enhancing the navy's cyber-security capabilities can also be achieved through the establishment of robust cyber threat intelligence mechanisms and information sharing partnerships with national and international cyber-security agencies. By fostering collaborations with renowned cyber-security organizations, the Bangladesh Navy can gain valuable insights into emerging cyber threats, industry best practices, and innovative cyber-security solutions, enabling it to stay ahead of potential cyber adversaries (Tawhid, 2022).

e. **Regular Cyber-security Audits and Assessments.** Conducting regular cyber-security audits and assessments is integral to identifying vulnerabilities and weaknesses within the Bangladesh Navy's digital infrastructure. These audits can facilitate a proactive approach to risk management, enabling

the Navy to address potential security gaps and implement necessary remediation measures to strengthen its cyber-security defenses and ensure the resilience of its critical digital assets.

Conclusions

In conclusion, the significance of cyber-security for naval operations cannot be overlooked in the contemporary maritime landscape. It is not merely a matter of protecting data and information but a critical component in maintaining operational integrity, securing national assets, and upholding international maritime security standards. By prioritizing cyber-security measures, naval forces can effectively mitigate cyber threats, safeguard sensitive information, and ensure the safety and security of their maritime operations in an increasingly interconnected world.

Bangladesh Navy's present cyber-security capability stands as a testament to its unwavering commitment to fortifying its digital defences and protecting its maritime interests in an increasingly interconnected world. Through its investment in cutting-edge infrastructure, specialized training programs, and partnerships, the Navy has positioned itself as a formidable force in the realm of maritime cyber-security, paving the way for a secure and resilient digital future for Bangladesh's maritime domain.

The Bangladesh Navy's proactive approach to cyber-security exemplifies its commitment to ensuring the safety, security, and integrity of its digital assets and maritime operations. While the challenges facing the Bangladesh Navy for cyber-security are multifaceted and complex, they can be addressed with a proactive and adaptive approach that emphasizes the resilience of its digital infrastructure and the fostering of a cyber-security-conscious culture among its personnel. By investing in comprehensive training programs, leveraging international partnerships, and allocating resources effectively, the Bangladesh Navy can overcome these challenges and reinforce its cyber-security capabilities, thereby safeguarding its maritime interests and contributing to the broader security and stability of the nation's maritime domain.

At the end, through a combination of advanced technology deployment, collaborative partnerships, comprehensive training programs, and stringent regulatory compliance, the Bangladesh Navy has established a formidable digital naval shield, poised to counter the dynamic and evolving cyber threats in the contemporary maritime landscape. As it continues to navigate the complexities of the digital age, the Bangladesh Navy remains steadfast in its mission to uphold national security and maintain its status as a beacon of excellence in maritime cyber-security.

Recommendations

The following recommendations are made in the article :

a. BN may establish a specialized cyber command centre to combat the cyber dangers and attacks of the twenty-first century. On a contract basis, civilian IT professionals could be employed by a cyber-team.

b. BN may continue to collaborate on other cyber-security initiatives at the same time, such as setting up cyber awareness programs, putting cyber-security protocols into place, providing advanced training for trainers, introducing cyber policy, incorporating secure communication channels, and creating cutting-edge IT platforms.

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Biography of the Writer



Lieutenant Commander Sk. Mahmud Hasan, (G), BCGM, psc, BN was commissioned on 01 June 2010 in the Executive Branch of Bangladesh Navy. He has undergone several professional courses both at home and abroad. He attended Coastal Defence Missile Officers' Basic Course in NAEI, China and Long Specialization Course on Gunnery in INS DRONACHARYA in India. The officer underwent Officer's Military Police Course (OMPC-50) in CMPC&S, Dhaka. He is a graduate from Defence Services Command and Staff College (DSCSC), Mirpur. Throughout his tenure, Lieutenant Commander Mahmud served on board various ships of the Bangladesh Navy in diverse roles. Notably, as Commanding Officer, he led three patrol crafts. In 2016, he was appointed as a peacekeeper in MONUSCO, Democratic Republic of the Congo. He is a proud father of one daughter.

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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.

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