International Journal of Arts, Languages and Business Studies (IJALBS), Vol.9; February, 2023; pg. 143 - 151

ANALYSIS OF ISSUES ASSOCIATED WITH EMPLOYMENT OF UNMANNED MARITIME VEHICLE FOR ENHANCED NATIONAL DEFENCE IN THE MARITIME DOMAIN

AHMED, A[A]., NA'INNA, A.M. [B] & ABBE, G.E.[C]

[a] Maritime Engineering Branch, Nigerian Navy Headquarters, Abuja, Nigeria
[b]Armament Engineering Department, Air Force Institute of Technology, Kaduna, Nigeria
[c]Aerospace Engineering Department, Air Force Institute of Technology, Kaduna, Nigeria

Abstract
An operational use of autonomous Unmanned Maritime Vehicles(UMVs) forces the adversary to maintain a defence posture, taking the focus away from the movement and targeting of manned units. The current UMVs can perform dirty and dangerous missions without the direct presence of the operator. The present study analysed issues associated with employment of UMVs for enhanced national defence in the maritime domain. The study adopted the field survey research design by conducting interviews and administrating questionnaires to 3 groups in the Nigerian Navy technical units. A descriptive research approach was adopted and data were obtained from both primary and secondary sources. A total of 250 copies of the questionnaires were physically distributed and the returned rate of the questionnaire represented 88.4 per cent validity. Four issues were identified in the present study to be associated with the employment of UMVs for national defence. One of issues is the increasing actors and objects in the maritime environment where 94.6 per cent of the respondent were in agreement with this assertion. Additionally, proliferation of flash point and quality control were identified as issues related to the employment of UMVs for national defence where there is 87.8 and 64.7 per cent respondents agreements respectively. Finally, is the issue of the diffusion into new environment where is 78.3 per cent agreement by the respondents. Consequently, there is need for concrete measures to be taken by relevant stakeholders to mitigate these issues for enhanced national defence in especially in maritime domain.

Introduction

UMVs have evolved over the years as navies from different countries endeavour to create new ways of completing tasks that would be dangerous to humans. These vehicles can be operated on the surface or underwater and may be remotely operated, partially or fully autonomous(Costanzi et al. 2020). For instance, the U.S. Navy has focused on enhancing the autonomous capabilities of UMVs to minimize human involvement and the associated risks together with advancing its war-fighting capabilities. The advancement of UMVs technology to date has largely coincided with the requirements of the security and defence systems, specifically for the challenges of Maritime Mine Countermeasures (MCM). This has been facilitated by the availability of commercial off-the shelf products and the decreasing costs of electronic components. Maritime MCM operations come with a high level of risk and have provided a successful test-bed for the use of autonomous systems(Global Security, 2019). However, the growing tendency is that unmanned maritime scan move beyond the challenges of maritime MCM and can be incorporated into many other security applications, as well as commercial applications. The deployment of personnel, vessels and aircrafts for maritime applications requires intensive efforts and large operational costs. In this way, UMVs can act as sentinels, enabling a more precise and selective approach in the deployment of conventional resources. As a result, many countries are adopting unmanned systems for improving the efficiency and reducing the costs of border and maritime patrolling operations, thereby increasing the demand for UMVs.

The current UMVs can perform dirty and dangerous missions without the direct presence of the operator. Increasing the autonomous features in the unmanned system would allow the seafarer to allot time to other operations while the UMVs would still be doing its job. UMVs can assist in conducting pertinent

missions, from mine countermeasures, anti-submarine warfare, oceanography and communication/navigation network nodes (Global Security, 2019).

The operational use of autonomous unmanned vessels forces the adversary to maintain a defence posture, taking the focus away from the movement and targeting of manned units. They would be forced to "allocate critical and limited resources across a larger set of defended targets, and away from the manned organic units which continue to advance into contested water space. With the Navy's focus on the development and fielding of UMVs, there is a heightened need for efficient vehicle propulsion systems. These systems will allow the respective UMVs to realize and achieve its maximum range, duration, and capability. As a result, energy management and efficient propulsion remains a fundamental limitation of UMVs. As more stress is placed on autonomy requiring more power intense sensors and computing, not having to compromise range and duration will necessitate the most efficient use of power for propulsion.This paper thus seeks to analyse of issues associated with employment of UMVs for enhanced national defence in the maritime domain

Methodology

Research Design

The study adopted the field survey research design. Field survey involved the conduct of interviews and administrating questionnaire with stakeholders and experts in the field. The study also administered copies of the questionnaire and interviews of subject matter experts and stakeholders on a sample drawn from the population. The research design also incorporated nature of research and level of research.

The nature of research was applied research employing empirical approach. The data employed for this research was an integration of quantitative and qualitative data. The data were collected and analyzed in relation to new technologies and national defence in maritime environment. This was achieved through the collection of data from primary and secondary sources.The level of research adopted was descriptive approach. This was used to analyze collected data, without manipulating the environment. Descriptive approach was also used to describe how new technologies has impacted on national defence in the maritime environment.

Sources of Data

The research data were obtained from both primary and secondary sources. The primary data for this study were obtained through questionnaires and unstructured interviews with subject matter experts on mechatronics, robotics and AI. Furthermore, data were obtained from officers at the Nigerian Naval Engineering College (NNEC) Sapele.The sources of secondary data included published and unpublished materials such as books, journals, newspapers, official publications, seminar and conference. Others are papers, lectures, policy papers, magazines and the internet. Additional secondary data were also obtained from the libraries of the Ejiga Library at the Armed Forces Command and Staff College (AFCSC) and National Defence College (NDC).

Population and Sampling Design/ Technique

The population and sampling design for the study included population of the study, sample of the study and sampling technique. The total population was estimated at 500. The research adopted a purposive sampling method to select 3 groups in the Nigerian Navy technical units. The 3 groups are NNEC Sapele, Fleet Support Group West (FSG W) and Fleet Support Unit Warri (FSU W) which comprise of students, instructors, technical personnel and administrators. This ensured that relevant features like service and the degree of involvement of respondents in administration, operations and technical training activities were considered. This is to meet the necessary requirement for external validity of the research.The sample size was calculated using Slovin's formula, details of these are contained in Appendix 1. Using a population size of 500 with a confidence level of 95 per cent and error margin of 5 per cent, the sample size is estimated at 215.5.

The study adopted the non-probabilistic purposive sampling technique. The strength of this sampling technique is that it allows for opinions of professionals and authorities in the field of study.

However, the weakness of the technique is that it targets a particular group of the people. Some of whom may be difficult to locate and interview for the purpose of the study. Such weakness was eliminated through verifications from 2 or more sources and references. The technique was also complemented with questionnaire that was administered to other stakeholders.

Methods of Data Collection

The methods of data collection that were adopted for the study include the field method and document analysis.The field method of data collection involved the use of questionnaires and interviews. Secondary sources of data were collected through print and electronic media and analysed using the archival library search. This proved very useful in clarifying the basic concepts and other aspects of new technologies and national defence that primary sources could not provide. This ensured that sufficient literature was obtained on employment of UMVs for national security to either reinforce or disprove the primary data.

Results and Discussions

Increasing Actors and Objects in the Maritime Environment

The demand for global trade is driving huge growth in ship traffic in the world's oceans, with four times as many ships at sea now than in 1992. The overall growth in ship traffic worldwide was 6 percent each year between 1992 and 2012, or 60 percent for the decade. After 2012, the number of ships grew faster, hitting an increase of 10 percent a year by 2019. Shipping traffic is one of many human activities in the ocean that has a heavy impact on the marine environment. Maritime shipping supports about 90 percent of global trade, according to the United Nation's International Maritime Organization. Most of this shipping relies on a few strategic routes that must accommodate both growing traffic and larger ships.

The Pacific Ocean saw ship traffic spike after 2008, especially near China. The Mediterranean, the Red Sea and the West Coast of the United States also saw big increases. Cargo shipping accounts for much of the growth. The biggest increase in ship traffic between 1992 and 2012 was along popular shipping lanes in the Indian Ocean and the Chinese seas. In the Arabian Sea and the Indian Ocean's Bay of Bengal, the average number of ships jumped more than 300 percent (Geophysical Research Letters 2020). Owing to further consolidation in the container shipping segment, the combined market share of the top 10 container shipping lines increased from 68 per cent in 2014 to 90 per cent in 2019.

To verify the assertions on increased actors and objects in the maritime environment, a survey was conducted in NNEC and FSG (W) involving the policy makers and the personnel that carry out patrol at sea. The result of the field survey conducted by the researcher reveals that 94.6 per cent were of the opinion that the increased objects in the maritime environment could be a serious challenge to the deployment of UMV for national security in the maritime environment. About 5.4 per cent of the total respondents were indifferent.

It could be inferred from the foregoing, that majority of the respondents agreed that increased objects in the maritime environment could hinder the employment of UMVs in the maritime domain for national defence. This buttresses the fact that the increased objects in the maritime domain are a concern to deployment of UMVs for national defence. The finding was corroborated researchers who averred that the increased actors and objects are concern for employment of autonomous UMVs in the maritime domain. Therefore, autonomous UMVs could be deployed for the conduct of ISR and other non-combat operations.

Proliferation of FlashPoint

The political and economic imperatives that impact on the diffusion of new technologies relevant to non-proliferation and export controls have changed so much since the end of the cold war that those responsible for implementing controls are finding it difficult to achieve consensus on what to limit, to whom and by how much. The real problem for the future will be how to manage new technologies to ensure universal economic growth and development, while also protecting technologies from misuse so that regional and global security and stability concerns are not compromised. This kind of balanced management

of new technologies will demand the cooperation of both the technology provider and the technology user. The mere extension of export control regimes along the lines that have been followed in recent years may no longer be viable because, as technology ownership has broadened enormously and the demarcation line between the technology provider and user is becoming increasingly diffuse. The genesis of preoccupations with proliferation can be traced back to the early cold war period, when it was thought necessary to prevent the revolutionary advantage of nuclear weapon capability from getting into too many hands.

The world was held hostage by doctrines and it would be illogical to expect that the defence perceptions of other sovereign countries would remain unaffected by massive proliferation of new technologies. Lee and Nacht (2020) perceivedthe problem of proliferation of new technologies to extend well beyond nuclear missile related issues. It includes other emerging technologies as well as potentially powerful conventional weapon technologies that are too diverse to control and are within the reach of many nations. Hence, the non-proliferation focus is now shifting to certain countries of concern and is increasingly based on an assessment of their inclinations or intentions to use their technological capabilities, depending on their past record of good or bad behaviour. The focus is thus changing from technology to 'technology user'. This is primarily because a certain degree of technology diffusion is now accepted as inevitable and the trend for this diffusion to increase is being recognized.

Gibbons and Herzog (2022) stated that the fundamental challenge for the future of non-proliferation and arms control will be how to balance competing interests among various nations on the issues arising out of technology diffusion. On the one hand, it is imperative for regional and global security that the misuse of technology should be blocked across the board while, on the other hand, it is equally imperative that healthy and stable international trade is encouraged to keep pace with overall socio-economic development and constantly evolving advances in technology. It is important to understand that technology is not merely a product or an artefact but represents the application of technical knowledge to serve a given purpose with greater efficiency or ease, with the help of technical options. The authors further asserted that the desired application is identified first and the technological innovation to realize it follows later. A mechanism is needed to define the (probably narrow) areas of technology that will be closely controlled. Herzog (2021) averred that complementary mechanism is also needed to target the control of a much broader band of technologies on particular end uses and end users. This is in fact the current trend among those states that cooperate to develop and enforce national export controls. However, to be sustainable, such a system must shift to consider how best to influence the decisions of those for whom technology options may be available independent of the actions of the relatively small group of participants in the existing control regimes (Herzog 2021). To verify the challenge of UMVs employment in the maritime domain, a survey was conducted in the NNEC, FSG (W) and FSU (W).

The result of the field survey revealed that 194 respondents representing 87.8 per cent agreed that employment of UMVs would cause proliferation of technology in the maritime domain. Only 15 respondents representing 6.8 per cent disagreed that deployment of UMVs would not generate proliferation of technology, the other 12 respondents undecided.

From the foregoing, it could be deduced that majority of the respondents agreed that employment of UMVs would cause proliferation of technology in the maritime domain. The outcome of the field survey revealed that the employment of UMVs in the maritime domain would create technological concern thus it is a negative factor on the impact of new technologies for national defence.

Quality Control Issues

The objectives of multilateral export control regimes include regulation of sensitive technology transfers with potential military applications and to identify countries of concern and prevent the proliferation of dual-use technologies to them. Given current trends in technology and international affairs, such multilateral export control regimes need to be subjected to serious and realistic reforms, consistent with changing times and changing technology dimensions.

Billing *et al.* (2021)examined the impact of new technologies on defence perceptions, and analyses the complex issues of technology denial to prevent the misuse of technology and of technology availability

for legitimate economic development, defence and security needs. Whitmore stressed that it is natural for developing nations to follow routes in pursuit of technology for economic development (and the rapid enhancement of military technology capabilities) similar to those which today's developed nations followed during their early economic development. However, to achieve cooperative security among mature and progressive nations, technology must play its rightful leveling role in ensuring security and development for all partners. Thus, achieving the correct balance between worldwide technology transfer and trade, and security concerns will require innovative approaches and careful planning by the arms control community.

It was affirmed that the unavoidable spread of advanced technologies has led to new and grave concerns regarding the proliferation of technologies into irresponsible or unstable hands. The rapid progress in IT during the past decade alone has opened up several new possibilities for using this technology for strategic or operational advantages. Increasing computing speeds, smaller hardware and innovative software approaches are creating even more options. IT has already revolutionized the battlefield with the trend for network-centric command and control philosophies.

Petroni *et al.* (2021) averred that the major new technological trend will be the increasing use of outer space for defence and security. As weapons become smaller and more efficient, deployment strategies and operational scenarios become more flexible, making a larger variety of options available to the user. The shrinking size and weight of strategic warheads are a classic example of how technology has made the attacker's job easier and the defender's job more difficult creating more demand for newer technology options to meet the new level of threat.

To verify the assertions on quality control issues on the impact of UMVs employment for national defence in the maritime environment, a survey was conducted in NNEC and FSG WEST involving the policy makers and the personnel that carry out patrol at sea. The result of the field survey conducted by the researcher reveals that 64.7 per cent were of the opinion that the quality control issues could be a serious challenge to the deployment of UMVs for national defence in the maritime environment. About 30.8 per cent of the total respondents disagree while 4.5 per cent were undecided.

From the foregoing, it could be inferred that majority of the respondents agreed that employment of UMVs could cause serious quality control issues in the maritime domain thus it is a negative factor on the impact of new technologies for national defence.

Diffusion into New Environment

The processes of the development and dissemination of technology through increased international trade and interdependence have evolved significantly since the end of the cold war. While there is increasing agreement about the need for export controls to prevent the most dangerous technologies going to dangerous actors, some diffusion of militarily relevant technology becomes inevitable in the remaining broad field of technology trade. The grey zone of potential but undetermined risk, where international agreements are difficult to achieve, is likely to become broader with the continuous evolution of technology. Technology diffusion process can create secondary suppliers that are capable of further innovation and that can offer alternative products in areas where a leading supplier from the industrialized group of nations may not wish to compete for political or economic reasons. Smaller companies that are dependent on innovation may represent more of a challenge to the implementation of export controls.

Technology exchanges between suppliers and recipients will therefore be of a different nature, where both may stand to gain equally in the final analysis. This is the true driving force for modern technology diffusion. The world today is far more interdependent and interactive. This has created an unprecedented acknowledgement of the need to work together for enhanced stability and peace in the world, with a focus on diminishing violence and instability. On the other hand, increased information may feed suspicions and perceptions of threats, while the instant media coverage of the most newsworthy events can create sharper reactions and additional pressures for action. Overall, public awareness has increased for better or for worse.

Billing *et al.* (2021)stated that the particular impact of military technology advances is the effective enlargement of the so-called battlefield. The traditional focus on the well-defined front line of battle has been altered by technological capabilities that can reach deep into enemy territory, thereby making additional

parties vulnerable to the overspill from a particular theatre of battle. Technology also enhances the tempo of operations and reduces the reaction time for decision making. These are the technological realities of today that have significant bearings on the security perceptions and defence operations of individual nations. How individual nations will adapt to these new technology options is as yet unclear. What is clear is that, with the new level of awareness of the advantages of established technologies, the pursuit of 'high-value technology' is going to be ever more intense.

The impact of some of the new technologies on international security and stability will be even more pronounced in the future. Changing perceptions of national security and the new dimensions of global technology diffusion will demand a fresh approach to arms control in general and export controls in particular. He also affirmed that diffusion of technology has become unavoidable in this new IT age, creating new challenges for the future of technology control. Global technology management must foster increased trade and cooperation among nations while not compromising or destabilizing any of the major regional or global security imperatives. New technology security linkages have emerged because of the evolving nature of new and enabling technologies and new threats of asymmetric war fed by the alarming spread of terrorism and religious fundamentalism. In order to find out the inference of diffusion of new technologies in maritime domain, a survey was conducted in the NNEC and FSG WEST involving students, instructors, engineers and technicians among others. The result of the field survey conducted by the researcher shows that 78.3 per cent agreed that diffusion of new technologies from maritime environment into other environments still remains a concern for UMV. About 19.0 per cent responded that diffusion of UMV into other environment would not be of any concern and the other 2.7 per cent respondents undecided.

From the foregoing, it could be deduced that majority of the respondents agreed that diffusion of new technologies from maritime environment into other environments still remains a concern for UMVs. The outcome of the field survey revealed that highly automated system originally designed for maritime use may be reconfigured for land based applications.

Conclusion

The advancement of UMVs technology to date has largely coincided with the requirements of the security and defence systems, specifically for the challenges of Maritime Mine Countermeasures. The current UMVs can perform dirty and dangerous missions without the direct presence of the operator. Increasing the autonomous features in the unmanned system would allow the seafarer to allot time to other operations while the UMVs would still be doing its job. The present study analysed issues associated with employment of UMVs for enhanced national defence in the maritime domain.

The study adopted the field survey research design by conducting interviews and administrating questionnaires with stakeholders and experts in the field. The level of research adopted was descriptive approach and data were obtained from both primary and secondary sources. The population and sampling design for the study included population of the study, sample of the study and sampling technique. The total population was estimated at 500. The research adopted a purposive sampling method to select 3 groups in the Nigerian Navy technical units. Accordingly, 250 copies of the questionnaire were physically distributed and the returned rate of the questionnaire represented 88.4 per cent validity.

One of the issues associated with the employment of UMVs for national defence include Increasing Actors and Objects in the Maritime Environment. In addition to affirming this issue from reputable scholars and studies, the result of the field survey conducted in the present study reveals that 94.6 per cent of the respondents were of the opinion that the increased objects in the maritime environment could be a serious challenge to the deployment of UMV for national security in the maritime environment. It could be inferred from the foregoing, that majority of the respondents agreed that increased objects in the maritime environment could hinder the employment of UMVs in the maritime domain for national defence. Deduction

The second issue identified with the use of UMVs is the Proliferation of Flash Point. The outcome from the present research indicated that that 194 respondents representing 87.8 per cent agreed that employment of UMVs would cause proliferation of technology in the maritime domain. Only 15 respondents representing 6.8 per cent disagreed that deployment of UMVs would not generate proliferation of technology, the other 12 respondents undecided. From the foregoing, it could be deduced that majority of

the respondents agreed that employment of UMVs would cause proliferation of technology in the maritime domain. The outcome of the field survey revealed that the employment of UMVs in the maritime domain would create technological concern thus it is a negative factor on the impact of new technologies for national defence.

The issue of Quality Control is another aspect of concern with the utilisation of UMVs for national defence. The objectives of multilateral export control regimes include regulation of sensitive technology transfers with potential military applications and to identify countries of concern and prevent the proliferation of dual-use technologies to them. To verify the assertions on quality control issues on the impact of UMVs employment for national defence in the maritime environment, a survey was conducted in NNEC and FSG WEST involving the policy makers and the personnel that carry out patrol at sea. The result of the field survey conducted by the researcher reveals that 64.7 per cent were of the opinion that the quality control issues could be a serious challenge to the deployment of UMVs for national defence in the maritime environment. About 30.8 per cent of the total respondents disagree while 4.5 per cent were Undecided.

Finally, the Diffusion into New Environment is an issue recognised in the use of UMVs for national defence. Changing perceptions of national security and the new dimensions of global technology diffusion will demand a fresh approach to arms control in general and export controls in particular. He also affirmed that diffusion of technology has become unavoidable in this new IT age, creating new challenges for the future of technology control. The result of the field survey conducted by the researcher shows that 78.3 per cent agreed that diffusion of new technologies from maritime environment into other environments still remains a concern for UMV. About 19.0 per cent responded that diffusion of UMV into other environment would not be of any concern and the other 2.7 per cent respondents undecided.

References

Billing, D. C.; Fordy, G.R.; Fried, K.E. and Hasselstrøm, H. (2021). The implications of emerging technology on military human performance research priorities. *Journal of Science and Medicine in Sport*, 24(10), pp. 947-953.

Costanzi, R. *et al.* (2020). Interoperability Among Unmanned Maritime Vehicles: Review and First In-field Experimentation. *Front Robot AI*, 7, 91.

Geophysical Research Letters (2020). Accessed online. Available at https://agupubs.onlinelibrary.wiley.com/journal/19448007

Gibbons, R.D. and Herzog, S. (2022). Durable institution under fire? The NPT confronts emerging multipolarity. *Contemporary Security Policy*, 43(1) pp. 50-79.

Global Security. (2019). Unamanned Maritime Vehicles. Accessed online on https://www.globalsecurity.org/military/systems/ship/umv.htm

Herzog, S. (2021). After the Negotiations: Understanding Multilateral Nuclear Arms Control. PhD Thesis at Yale University Graduate School of Arts and Sciences. Dissertations, 58.

Lee, M and Nacht, M. (2020). Challenges to the Nuclear Non-Proliferation Treaty. *Strategic Studies Quarterly – Perspective*, 14(3), pp. 95-120

Petroni, G.; Gottardi, G. and Bianchi, D.G. (2021). The New Space Race: Risks and Opportunities. *Italian Institute for International Political Studies*. Available online on https://www.ispionline.it/en/pubblicazione/new-space-race-risks-and-opportunities-32060

International Journal of Arts, Languages and Business Studies (IJALBS), Vol.9; February, 2023; pg. 143 - 151

International Journal of Arts, Languages and Business Studies (IJALBS), Vol.9; February, 2023; pg. 143 - 151

APPENDIX 1

SLOVIN'S (1960) FORMULA FOR SAMPLE SIZE

$$n = \frac{N}{1 + Ne^2}$$

where:
n is the sample s
N is the populatıon sıze
e is the margin error
1 is a constant value

$$n = \frac{496}{1 + 496 \times 0.05^2}$$

$$= \frac{496}{2.24}$$

$$n = 221.43$$

Source:<http://www.slideshare.net/ludymae/chapter-8sample-sampling-techniques> accessed 27 March 2022.