The International Journal of Business Management and Technology, Volume 6 Issue 1 January-February 2022
ISSN: 2581-3889

Research Article Open Access

The Importance of Quantum Technology in National Defense in the Future

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Abstract: *Quantum technology is one of the new and advanced technologies to support national defense. Therefore, we ask a research question: what are the forms of applying quantum technology to help national defense and security in the future? For this reason, we use a literature study to answer this research question so that the desired results are obtained. From the research conducted, there are various benefits derived from applying quantum technology to support national defense and security. Including detecting hidden enemy forces, supporting operations in an environment with decreased GPS, protecting highly classified data from enemy attacks, and various other benefits that did not obtain from previous technologies. Thus, a country needs to study and develop quantum technology to support national defense and security in the future. Given the growing development of technology, the threats posed are increasingly varied.*

Keywords: National Defense, Quantum Technology, Science and Technology Development

I. INTRODUCTION

Today, technology is developing very rapidly, accompanied by the development of the national defense and security system. Technology has always played an essential role in defense and warfare. Technology can provide an advantage in dealing with enemies with greater numerical capacity or firepower, but on the other hand, each country is faced with increasingly varied threats. Technology also has an increasingly vital role in meeting new and rapidly changing defense risk contexts.

National defense and security are some of the main application areas of technology, including quantum technology. Quantum technology is a new technology and indeed not the only advanced technology applied in civil and military applications, but also quantum technology needs special attention because quantum technology can potentially reshape the world and trigger a new arms race [1]. For this reason, conducted this research to provide an overview of the importance of using quantum technology in maintaining the defense and security of a country in the future.

II. RESEARCH METHOD

This research was conducted using the literature study method. A literature study is a data collection method in which the literature is obtained from the internet, journals, books, and other written works [2]. Literature studies are carried out to find a problem to be researched, seeking relevant information by the problem being studied, reviewing several fundamental pertinent theories to the issue being studied, and deepening knowledge about the situation and field under study by examining the results of previous research.

III. LITERATURE REVIEW

a. National Defense

National defense is responsible for preserving and maintaining a democratic rule of law as it is known today, such as eradicating drug trafficking both from within and outside the country, stopping human trafficking, protecting border areas, preserving the interests of the state at the international level, including economic, political, environmental and military interests. Based on the Law of the Republic of Indonesia Number 3 of 2002, it is explained that national defense is carried out to defend the sovereignty of the state, territorial integrity, and the safety of the entire nation from threats and disturbances to the integrity of the country and state. In Indonesia, national defense is essentially a universal state defense, the implementation of which is based on awareness of the rights and obligations of all citizens and belief in one's strength [3].

b. Quantum Technology

Quantum technology has a function derived from engineering the state of a quantum system [4]. Quantum technology applies the principles of quantum physics to technological applications. In general, quantum technology is not perfect but could have significant relevance for the future of military sensing, encryption, communications, and congressional oversight, authorization, and appropriations. There are three types of applications of quantum technology in supporting military advances for national defense and security [5], namely:

1. Quantum Sensing

Quantum sensing uses the principles of quantum physics in a sensor. Quantum sensing creates a potentially transformative opportunity to exploit complex quantum mechanical phenomena in new ways to make susceptible multiparameter measurements. Quantum sensing can be used to realize an unprecedented combination of range, resolution, and sensitivity for the size of desired critical parameters. Data from high-sensitivity and reliable sensor devices that detect early signs of equipment failure can be analyzed using predictive models [6] to gain insight into future performance and assess operational conditions with greater confidence.

2. Quantum Computing

Quantum computing is a technology designed to utilize the principles of quantum mechanics, a theory in physics that explains the properties of nature at the atomic and subatomic levels [7]. In contrast to classical computers that encode information in bits represented by a value of 0 or 1, quantum computing uses quantum bits or qubits.

Quantum computing capabilities can enable solving problems up to 100 million times faster than classical computers. In other words, quantum computing can solve problems much faster than classical computers and even handle specific issues that classical computers cannot solve today.

3. Quantum Communications

Quantum communication is closely related to quantum information processing and quantum teleportation. Quantum communication is the first thoughtfully developed and most technologically mature quantum technology. Like other types of communication, quantum communication uses photons. Most quantum communication systems work with photons in the visible or near spectrum and are similar to traditional optical or laser communications. An optical communication link seeks to provide high data rates via laser beam modulation; Quantum communication channels strive to deliver highly secure communication by manipulating each photon in the beam. Unlike conventional encryption, quantum communications are considered to be unhackable and thus represent the future of safe transfer of information for banks, power grids, and other sectors.

c. Utilization of Quantum Technology in National Defense

Quantum technology can disrupt and affect many human activities, where quantum technology brings profound new capabilities, enables transforming cybersecurity, and allows to solve problems that have never been solved before. Thus, quantum technology has the potential to reshape the world and spark a new arms race [1]. Therefore, a country must prepare itself by utilizing and developing quantum technology to maintain the defense and security of its government. The following is the application of quantum technology in supporting national defense and security.

1. Quantum Sensing

Quantum sensing can provide enhancements to several military capabilities. For example, it could give alternative positioning, navigation, and timing options that could, in theory, allow the military to continue operating at full performance in environments experiencing GPS downgrade or GPS rejection. In addition, quantum sensors could potentially be used in intelligence, surveillance, and reconnaissance (ISR) roles. The successful development and deployment of such sensors could lead to significant improvements in submarine detection and, in turn, jeopardize the survivability of sea-based nuclear deterrents. Quantum sensors could also allow military personnel to detect underground structures or nuclear materials due to the expected "extreme sensitivity to environmental disturbances." The sensitivity of quantum sensors can also enable the military to see electromagnetic emissions, enhancing electronic warfare capabilities and potentially helping to locate hidden enemy forces [8], [9].

For quantum sensing, potential applications such as quantum PNTs and radar and quantum sensors are of great interest to the military. Therefore, it is up to the military to fund, support, and guide research and development in this area to make these potential applications a reality.

2. Quantum Computing

The use of quantum computers needs to be a concern to improve military weapons in the future. That is because quantum computers use unique parts to run algorithms and solve math and computer problems that are very difficult for classical computers to solve at lightning speed. These computers can better identify targets for autonomous weapons without requiring human interaction in warfare. Quantum computers are also effective in running simulations that can demonstrate military deployments, possible strategies, and other scenarios to develop better war strategies [10], [11].

3. Quantum Communications

Quantum communications are beneficial for governments and defense agencies to protect large amounts of classified data with long-term sensitivity. The only effective way to ensure protection from the constant threat of cyberattacks and espionage is to exchange unbreakable quantum keys. Quantum communication technologies can also use QKD (Quantum Key Distribution) to protect sensitive encrypted communications against hostile interception and protect long-term data from future quantum computer attacks.

IV. CONCLUSION

Quantum technology is a new technology and an essential technology in the future that has the potential or significant impact on the national defense and security sector. With the various benefits of quantum technology, especially in national defense and security, quantum technology is crucial to be developed and studied more deeply by a country to improve its national defense and security in the future. Bearing in mind that the more technology creates, the more it generates and the various threats. However, since quantum technology is still in its infancy, the challenges of its practical application remain to be overcome. Must avoid overestimation of future military implications. The development of quantum technology and debates on its application to military affairs must continue to be followed, and should carefully consider the impact on national security.

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