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Adoption and Deployment of 21st Century Technologies in Armed Forces Operations

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ABSTRACT

Armed forces across the globe have been continuously modernizing through the deployment of hi-tech computers and nanotechnologies to perfect information acquisition and analysis and data transmission during missions and operations to make them more powerful and enhance their competitive advantage. This study presents an overview of the opportunities provided by twenty-first century military technologies and their advantages, specifically in terms of system integration, communications, and capability to shape modern warfare. The study concludes by recommending the importance of the Ministry of Defense through the provision of adequate funds and budgetary allocations for research, development, and procurement of high-tech equipment like TALOS, FIST, FELIN, IDZ-ZES, RATNIK-3 smart suits for tactical operations to support soldiers for an effective discharge of assigned combat missions during insurgencies and battlefield reconnaissance and domination.

Keywords : adoption, armed forces, military operations, deployment, technology

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Introduction

The world is changing every day. Electric vehicles, virtual reality, 3D printing, quantum supercomputers, and a never-ending list of innovations brought about by computers keep growing. Although these technologies have been beneficial for civilian use, the military may be one of its biggest benefactors. The use of technology to help drive new ways of conquering physical and figurative battlefields of tomorrow has made it apparent that computers are the superweapons of the future. Today, technology is capable of providing exceptional amounts of data and information that must be processed and delivered to the right person, at the right time, and in a useful way to be operationally relevant to sense, monitor, transport, process, and analyze data that will influence tactical decisions at the edge (Keller, 2019).

With the revolution in information technology (IT), the experience of profound changes in the nature of the world in the information age has revolutionized changes in our lifestyle. For example, our homes now operate automatically when no one is in with the use of smart technology. The IT revolution made it possible to communicate with someone located on the opposite side of the planet in real time through telecommunications and video conferencing applications like Skype, WhatsApp, telegram, etc. Owing to the IT revolution, we also enjoy simultaneous multimedia-based communications in military operations and business practices (Hong, 2020). It is worth noting that the global technological revolution has led to social, economic, political, and personal changes throughout the world like the agricultural and industrial revolutions of the past. These technological revolutions, with advancements in biotechnology, nanotechnology, materials technology, and IT, have not only transformed the human quality of life but also impacted the power shift among nations who deploy them in their warfare scenarios (Mallick, 2020). Military organizations that can adopt and promote new technologies have a critical edge in modern warfare. Such technologies have an impact across the whole spectrum of warfare. In view of the above, this study explores the importance of deploying modern technologies in military warfare, considering the history of technology adoption, smart sensor technologies, and communication systems, along with the associated challenges and solutions.

History of Technology in Military Applications

The start of the ongoing information revolution in military affairs can be traced to the late 1930s and early 1940s. This was when the first digital computers were developed, many of which were preoccupied with military tasks such as ballistics calculations and code-breaking during World War I and World War II (Campbell-Kelly, Aspray, Ensmenger, & Yost, 2013). The use of computers has developed quite spectacularly from what, in hindsight, appears to be a rather humble beginning to advanced calculators and systems that process and store exponentially increasing amounts of data, which is often strategically important for prompt decision making by commanders. However, computers have been widely used to exert control over the physical world through computerized industrial control systems (ICS), which is common in different sectors of industry and infrastructure for manufacturing and development purposes during the industrial revolution to meet the growing demand of citizens, goods, and services (Stouffer, Pilletteri, Lightman, Abrams & Hahn, 2015). This transformation led to the use of a simple programmable logic controller (PLC) to perform specified tasks - such as powering an elevator, a set of traffic lights, or an industrial appliance - by "monitoring the state of input devices and making decisions based upon a custom program to control the state of output devices" (Advance Micro Controllers Inc., 2015).

Advances in IT have contributed to a growing array of strategic capabilities for armed forces across the globe, leading to new technologies for the provision of high-resolution data on land terrain, environmental, and tactical conditions that can be communicated to troops and their command instantaneously during combat missions and reconnaissance. In other words, technology has always been used to develop improved tools of warfare. For instance, in the modern age, which is widely accepted to have started after the French Revolution, systematic scientific research has enabled the development of new technologies and innovations for both military and civilian use. These have had effects both on the society and the nature of warfare. European nations, besides waging wars among themselves, used their superior technologies to subjugate and colonize other nations. Reflecting on the history of the Indian subcontinent, we can observe that since the days of invasion by Babur, foreigners have exploited their superior technologies, and at times, superior strategies and tactics to subjugate India. The present age, which is being referred to as the post-modern age or knowledge age, is unfolding an unprecedented revolution in technologies. These technologies have not only touched myriad activities in the civil field but have also initiated a revolution in military affairs (Anand, 1999).

Battlefield Digitization

Battlefield digitization (The US White House, 2021) is the application of commercial information technologies to acquire, exchange, and employ timely information throughout the battlespace, tailored to the needs of each commander, shooter, and supporter, allowing them to maintain a clear and accurate vision needed to support both planning and execution. Digitization allows the warfighter to communicate vital battlefield information instantly, rather than through slow voice radio and even slower liaison efforts (The US White House, 2021). This deployment provides rapid and effective responses on intelligence, surveillance, and reconnaissance to provide decision-makers and battle commanders with dominant battle space knowledge in a timely manner (The US White House, 2021). An increased connectivity through battlefield digitization, smart devices, and access to media and social networks are crucial to modern warfare. This timely availability of information is crucial for occupying forces to ensure the support of society and for defenders to maintain support and resistance against the aggressor (Flournoy & Sulmeyer, 2018).

Military Applications of Information Technology Revolution

The IT revolution also brought dramatic changes in modern warfare. The core of modern warfare is information. As emphasized in Joint Vision 2010, information superiority is the sine qua non of desired military capabilities. Common battlespace awareness, location certainty for friendly and enemy forces, and real-time dissemination of information create the basis for seamless operations. Information superiority is vital to the ability to employ precision strike assets in a manner most likely to create the desired results (Hong, 2020).

A classic example of military applications is the US Defense, where officials have made a significant progress in recent years in understanding how technologies can be developed and adapted at an acceptable cost to the national security. In July 1999, the General Accounting Office of the USA published a report titled "Better Management of Technology Development Can Improve Weapon System Outcomes." In this report, measures, referred to as technology readiness levels, were suggested to gauge a technology's maturity, including communications and networking of military gadgets to connect for radar, reconnaissance, and identification of threats to the nation's security (Mallick, 2020). Moreover, US Marine (2016) emphasized the importance of breakthroughs through the use of technologies: "A military that is slow to exploit

technological advances and adopt new ways of fighting opens itself to a catastrophic defeat."

Communications as viable asset for Mission Dominance

Communication is a key component of every military' s control and dominance over a battlefield (i.e., Choobineh, Anderson, Fazen, & Grimaila, 2011; Dalmolen, Kollenstart, Moonen, & Bastiaansen, 2021). It is crucial because without the ability to send and receive messages, relay orders, or plan tactical advancements and strategies, soldiers are left to figure out a plan through the conventional use of charts, diagrams, and terrain topography of the battlefields, which is inefficient given our ability to communicate, gather information in real-time, and use weapon systems across borders and seas. Its application in battlespace awareness assures real-time information, accelerated operational tempo, and highly accurate identification of friends and foes on the battlefield in a tactical combat because tactical units will have timely and relevant information about the battlefield (Hong, 2020).

This development led to the use of command and control (C2) capabilities. The C2 capabilities are increasing as the direct control of units on a battlefield becomes available through an increasing number of sensors, direct commands, and artificial intelligence (AI) inclusion in decision making. Land, sea, air, space, and informational power become an extension of cyber power as they are increasingly used in different systems to improve the performance of commanders (Česnakas, 2019). Similarly, let us take a look at an example where the British introduced railways and telegraph in India for civilian and military purposes. The development of these technologies promotes the transportation of troops and equipment quickly from one trouble spot to another through railway networks for smaller-scale combat operations, multilateral peace operations, noncombatant evacuations, counterterrorism activities, and humanitarian and disaster relief operations (Hundley & Gritton, 1994; Roland, 2020). The use of command and control technologies increase C2 capabilities through the live monitoring of tactical operations and direct coordination of soldiers for improving performance and the success of operations. In 2018, the Chinese military invested heavily in the development of AI in the military sector to harness it for military uses. These included autonomous drone swarms, software for defense against cyberattacks, and programs to mine social media to predict political movements and secure their lands and borders from external forces, similar to the case of the Russian invasion of Ukraine land (Sherman, 2022), which led to the loss of lives and properties for many Ukrainians who had to scamper for safety and seek refuge in neighboring countries

such as Poland (Cummings, 2017; Segal, 2018). In this sense, the use of cutting-edge communication tools like Wi-Fi, encrypted codes, satellite communications systems, and instant messengers allow commanding officers and military members to spread messages and tactics in real time to give them a comparative advantage, especially against enemies with rudimentary means of communication access to all parts of the world (Brown, 2021; Dada & Akila, 2021).

Development of Battle Management Software

Battle management software, in the form of a battle control language and associated support, is needed for computer-assisted decision support and battle management. The capacity of computer hardware to process data has increased at a tremendous rate. This capacity is expected to grow by two orders of magnitude every decade. The constraint on a fuller use of this capacity is the development of software programs to carry out various types of analysis for efficient and reliable intelligence extraction, synoptic organization of intelligence, and interpretation of command decisions as detailed directives to the active elements. This will continue to be a critical area for battlefield management, and will probably be the pacing factor for implementing an agile-force strategy. Battle control languages will enable army personnel to move data, extract information, compare courses of action, and even make automated decisions, all without a concern for the details of computation (Douglas, 2021). This technology offers capabilities for:

i. simulating and evaluating alternative courses of action
ii. exercising command and control over the battlefield in near real- time with accurate and reliable information
iii. providing an unprecedented degree of realism in training exercises and analytical work.

Use of Smart Sensor Technology

Smart sensor technology is another key component of the adoption of technology in warfare as targets need be identified and tracked for engagement; further, soldiers on missions have to collect data on terrain, weather, and locations of civilian populations; identify key infrastructure; and differentiate friendly forces from enemies to reduce casualties (O’ Hanlon, 2018a).

This key component includes multispectral infrared focal plane arrays and uncooled infrared

detectors attached to smart suits to assist soldiers during night missions with infrared night vision and heat detection equipment, improved capabilities of rifles and weapon sights, and passive terminal homing guidance for smart missiles, (Boulanin, Goussac, Bruun & Richards, 2020; O' Hanlon, 2018b). Similarly, smart exoskeleton suits such as tactical assault light operator suit (TALOS) are equipped with internal heating and cooling sensors for all terrains. They can lower the body temperature, decrease fatigue in hot regions, and prevent stiff or numb joints from freezing temperatures in cold regions. This increases the success rate of missions when compared with conventional soldiers who do not deploy such smart technologies (Douglas, 2021).

Biotechnology and Smart Suit

Biotechnology helps produce both natural and artificial materials – such as composites and customized polymers – with specified physical, chemical, and electrical properties. Advances in this area will depend on the simultaneous development of computer-aided bio-molecular design and low-temperature manufacturing (Boulanin, Goussac, Bruun & Richards, 2020). A potential implication of materials produced with the help of biotechnology is increasing the number of effective personnel in a battle by speeding the return to duty of injured soldiers.

Tactical Assault Light Operator Suit (TALOS)

In 2013, US Special Operations Command launched the first-generation version of TALOS, a super soldier suit that will not only protect soldiers from bullets and other projectiles but also increase their mobility and strength. A TALOS is an ultra-advanced protective armor developed to enhance tactical awareness and physical strength; biomedical monitoring; detection of ballistic penetration, pneumatic ankles and knees, motor endurance; offloading of payload weight; and computerization of networked helmets to support mobility and logistics applications. It was developed under the leadership of Chief William McRaven of the United States Special Operations Command (SOCOM) as a protection system, and strength-enhancing exoskeleton, when compared to regular army capabilities (Tucker, 2019).

Currently, soldiers in developed countries like the USA, the UK, and France have started training soldiers on how to perform in combat, working with a variety of new technologies (Douglas, 2021; Freedberg, 2013). In conjunction with the US Army Expeditionary Warrior

Experiments (AEWE) program, the tech company AimLock Inc. is transforming every soldier into a sharpshooter. Their AimLock-equipped rifles use a combination of software and hardware to increase accuracy when firing at moving targets and eliminate shooter errors. Soldiers can now remain underwater for up to two hours using a new technology (Freedberg, 2013). Soldiers can now also remain underwater for up to two hours using a new military rebreathing device that converts the air they breathe out into pure oxygen, doubling the time allotted by an average scuba tank (Tucker, 2019).

The U.S. is even using the latest advances in off-world technology to prepare for threats to space-based infrastructures with a plan titled "Space Mission Force: Developing Space Warfighters for Tomorrow." These soldiers are being trained to combat attacks on the nation's satellites, and as we continue our efforts at off-world colonization, what is now just a small piece of the military could become an integral part of what keeps citizens safe from enemy threats (Houser, 2017).

Deployment of Drone Technology

Among the more applicable understandings of computer technology, we can see the most obvious example is drone technology. Civilian use of drones is mostly reserved for photography or leisure, but the military uses incredibly expensive and precise unmanned aerial vehicles to complete tasks ranging from reconnaissance to airstrikes (Brown, 2021). This is likely the first thing people think of when they imagine computers and the military because it requires a highly-trained group sitting at a monitoring station to operate these vehicles. This advantage provides military access to airspace worldwide without the loss of manpower when a vehicle is shot down (Dada & Akila, 2021).

As for the development of drones, they were first used for aerial photography of regions that were inhabitable or could not be photographed by airplanes and helicopters, mostly for civilian purposes. However, over the years, the USA Defense saw an exponential importance of its use for military operations, and many drones were developed for combat missions in Iran to give air support to the US soldiers. It is worth noting that drones are not just for combat missions; they are also used to monitor enemy activity, acting as both the eyes and ears of the military. Similar usage includes the DARPA's SHARE program, designed for the collection, processing, and sharing of information at multiple levels of security to a single handheld device to help commanders run battlefield missions as smoothly as possible, proactively neutralize enemies,

and take other political-diplomatic actions for invasion (Houser, 2017; Pirnuta, Neǧas, Boscoianu & Secarea, 2011).

New Challenges and Solution for the military applications

One of the most serious challenges is cost constraints, which make the application of these machines extremely limited in the military sector. Moreover, extreme design sophistication, programming, and strong centralization of control over production are the key characteristics of military-oriented technological development. This technology entails a high cost and governments do not have a budget for deploying this technology, which hampers its applicability, development, and innovation. Other challenges include the non-availability of an extant communications system and virtual equipment to train personnel, the lack of combat simulations for soldiers for real-world exercises, the non-availability of training programs on cutting-edge technologies, and the use of smart technologies and smart suits to support their missions.

On the other hand, a continuing challenge to the security of our nation stems from the threat of international and domestic terrorism. Terrorists, whether from well-organized or loosely organized groups, have the advantage of being able to take the initiative in the timing and choice of targets. Terrorism involving weapons of mass destruction represents a particularly dangerous potential threat that must be countered. Countering terrorism effectively requires close day-to-day coordination among many executive agencies, including the Departments of State, Justice, Energy, and Defense; the Federal Bureau of Investigation; and the Central Intelligence Agency. Part of the challenge is to identify needs, seek common approaches, and coordinate the development of new technologies to counter terrorism. This is accomplished through the interagency Technical Support Working Group. Priority is given to projects that could be of use to more than one agency, such as portable X-ray machines. In addition, individual agencies conduct research and development for their own specialized needs. For example, the Federal Aviation Administration is developing improved aircraft cargo containers that can withstand explosive devices (The US White House, 2021).

Conclusion

Modern military technology is still in its infancy in most developing countries such as China, France, Japan, South Korea, UK, and USA, even with the development of smart suits and drones. Over the years, many nations still use conventional warfare strategies and equipment for missions. It is worth noting that countries have spent lots of resources on the development and perfection of military technology to gain a competitive advantage in the battlefield. Unfortunately, little has been achieved. Taking a look at the Russian invasion of Ukraine, modern armed forces must endeavor to obtain cutting-edge military equipment to gain superiority over the enemy by qualitative means by deploying advanced technologies. This must be guided by the law of warfare, from a shift from mass and mobility to non-traditional methods of enhancing relative combat effectiveness by integrating numerous evolving technologies.

Past trends in military warfare have recorded technological breakthroughs and success, and this can only continue when the military takes advantage of twenty-first-century technologies for use in their countries by investing in research and development, along with their use for securing land, air, and seas to prevent an invasion. Undoubtedly, as we enter the information age, the military must recognize the importance of information warfare, precision fire, and a host of other technologies to ensure the aims and objectives of each segment of the armed forces—marine, air, and land forces—is met for protecting and securing the lives and properties of its citizens internally and externally from invasions across the globe.

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