Original Research Article

Optimizing Performance Through Retrofitting: Strategies for Effectiveness, Defence, and Resiliency to Enhance Safety and Reliability

Mohammad Hossein Moghimi Esfandabadi (ID)**, Ali Esmaeili * ** (ID) **and Kamyab Karbasishargh**

Department of Mechanical and Aerospace Engineering, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, iran

* aliesmaeili@ferdowsi.um.ac.ir

Abstract

This paper explores strategies to enhance safety, reliability, and performance in military-dependent industries, focusing on five key dimensions. Diversity is highlighted as crucial for effective defence, enhancing system resilience and safety by integrating various capabilities. Technological innovation in AI and robotics empowers military domains against threats, reducing performance risks. The impact of advanced technologies on effectiveness is analyzed. Military infrastructure is emphasized for mission success, with strong, flexible infrastructure vital for safety and reliability. The review examines the role of robust infrastructure in risk reduction. Human resources are crucial, with targeted training programs empowering specialized forces. The importance of investing in human resources is underscored. Communication and coordination among military systems are essential for success, with effective collaboration being complex but necessary. The review provides a roadmap for optimizing system performance in the military field, addressing the dynamic and evolving nature of military applications. This comprehensive approach ensures that military systems are robust, reliable, and capable of meeting contemporary challenges.

Keywords: Retrofitting; Effectiveness; Defence; Resiliency; Safety & Reliability.

1. Introduction

Complex systems, whether in the military-industrial complex, the aviation industry, or any other field, require a thorough understanding of their components and how they interact. This understanding is crucial for identifying potential flaws and risks and implementing effective strategies to mitigate them. By examining the intricate web of factors contributing to a system's performance, we can develop more robust and resilient systems better equipped to adapt to changing circumstances. In this context, 'fragility' becomes particularly relevant, highlighting the vulnerabilities arising from complex interactions between components. By acknowledging and addressing these vulnerabilities, we can build more reliable and efficient systems better suited to meet the challenges of an ever-changing world [1,2]. Military industries hold the key to a nation's ability to

defend itself. But unlike a simple lock and key, their effectiveness relies on a complex and intricately woven web of factors. The five fundamental elements that were explored and contributed to a robust and resilient military-industrial complex:

1.1 Diversification: A Strategic Defence Network

A military solely focused on tank production was imagined. Their capabilities would have been woefully inadequate in a future dominated by aerial combat. A nation's defence is strengthened by diversification, fostering a broader skillset and production capability. This allows industries to produce, maintain, and repair a broader range of equipment, ensuring effectiveness across diverse sectors like aircraft maintenance, naval technology, and cyber defence [3]. Think of it as building a strategic defence network, where each node – a

specialized sector within the industry – contributes to the overall defensive posture. Diversification fosters the creation of high-quality, adaptable parts, systems, and equipment. This adaptability is crucial for responding effectively to emerging threats and unforeseen challenges on the battlefield. Just as a well-diversified ecosystem can weather environmental changes, a diversified military industry can adapt to the ever-shifting landscape of modern warfare.

1.2 Technological Innovation: The Constant Arms Race of Progress

New technologies are the cutting edge of the defence, acting as both a **potent weapon and a robust shield**. Military industries must prioritize continuous innovation to stay ahead of potential adversaries [4]. This isn't a one-time arms race; it's a constant push to develop the next generation of defensive and offensive capabilities. Advancements in:

- **Weaponry and Communication Systems:** The development of next-generation weaponry and secure communication networks has been ensured, allowing a nation to effectively project force and maintain clear command and control channels. A soldier on the battlefield is imagined, equipped with cutting-edge weaponry, and seamlessly connected to their command center. This technological edge has been translated to a tactical advantage.
- **Cyber Defence and Logistics Management:** Breakthroughs in cyber defence technologies have safeguarded critical infrastructure and information systems, while advancements in logistics management have optimized resource allocation and deployment capabilities. Cyber defence is thought of as a digital shield, protecting vital networks from infiltration, and logistics management is seen as the streamlined flow of resources that has kept the entire military machine running smoothly.

1.3 Infrastructure: The Unsung Hero, Forging the Future

The infrastructure of military industries has been acted upon as the unsung hero, providing the foundation for a strong national defence. This has included facilities, production lines, and research centres. By constantly being updated and improved, this infrastructure can be ensured to remain:

- **Efficient:** Modern facilities and production lines have streamlined operations, maximized output and minimized production delays. A state-of-the-art production line churning out advanced weaponry at peak efficiency is imagined. This has translated to a military that can be quickly equipped with the latest technology.

- **Resilient:** Up-to-date infrastructure can withstand potential attacks or disruptions, ensuring continued operation even in challenging circumstances. Think of a fortified research center, able to continue developing new technologies even amidst conflict. This resilience ensures steady advancements to keep the military at the forefront.
- **Capable of Facing New Threats:** Advanced research centers have allowed for the developing and testing of new technologies, enabling military industries to be adapted and counter emerging threats. A team of researchers working tirelessly in a cutting-edge facility is imagined, with solutions to combat the latest innovations in enemy weaponry being developed. This forward-thinking approach has ensured the military can stay ahead of the curve.

1.4 Human Capital: The Minds Behind the Machine

A skilled, motivated, and well-trained workforce is the engine that drives military industries forward. These individuals are the ones on the ground, operating complex equipment, conducting research and development, and maintaining overall operational readiness. Investing in human capital through:

- **Training and Development Programs:** The workforce has been equipped with the latest skills and knowledge to operate effectively in a rapidly evolving environment. A soldier adept at using the latest weaponry and tactics is imagined, thanks to comprehensive training programs. This has translated to a more effective fighting force.
- **Leadership Development:** A culture of innovation and strategic thinking has been fostered, enabling the workforce to be adapted and contributing to advancements in military technology and tactics. A forward-thinking leader who can not only execute plans but also develop new strategies to counter emerging threats is imagined. This leadership has fostered a culture of continuous improvement within the military-industrial complex.

1.5 Communication and Coordination: The Invisible Orchestra of Success

Advanced information and communication management systems are the invisible strings that orchestrated success within military forces and industries. The **swift and accurate transmission of information** has been enabled by these systems, facilitating seamless communication between different units, departments, and even across geographical distances. This ensures:

- **Targeted Cooperation:** Enables different branches of the military and various industry

sectors to work together effectively towards achieving a common objective.

- **Coordinated Response:** Allows for a unified and efficient response to any situation, whether a training exercise, a natural disaster, or a real-world conflict. Imagine a coordinated air strike where all elements – from fighter jets to ground support – receive clear and concise instructions, leading to a successful mission.

These five elements – diversification, technological innovation, infrastructure development, human capital investment, and robust communication systems – were not independent but rather worked in synergy. A strong military-industrial complex was like a well-oiled machine, with each part contributing to the smooth and efficient operation of the whole. By prioritizing and nurturing these elements, nations ensured they possessed a robust and adaptable defence system capable of being safeguarded for their security and interests in a complex and ever-changing world.

This research examined strategies for increasing effectiveness, defence, and resilience against various challenges and crises. The purpose of this report was to provide practical solutions to improve capabilities and stability in the face of various threats. [5,6,7,8].

2. Advantages Of Diversity and Specialization in Military Industries

2.1 Increased Production Capacity:

Diversification in the production of military components, equipment, and systems being contributed to the advancement of military industries' capability and efficiency in responding to the diverse needs of armed forces.

In renowned armies worldwide, production capacity in military industries and military research are of particular importance. Some of the methods for increasing production capacity in renowned armies include [9]:

1) Establishing Advanced Military Industries:

Renowned armies usually prioritize the development and modernization of their military industries. For example, the U.S. military industry, with reputable companies such as Lockheed Martin and Boeing, has been made significant progress in the aerospace and defence sectors.

2) Collaboration with Private Industries:

Some armies focused on collaborating with private companies and utilising their capabilities to produce modern military equipment and technologies. For instance, in collaboration with renowned information technology companies like Google and Microsoft, the U.S. Army developed advanced encryption systems and modern surveillance technologies.

3) Providing Financial Support and Facilities:

To enhance production capacity in military industries, specific financial support and facilities were provided by some countries for related companies and think tanks. For example, European countries usually allocate significant budgets to military research to achieve advanced military technologies. These methods enhance countries' military capabilities and help them confront modern security challenges. Figure 1 shows the graphical representation of the analysis process to express the performance optimization process based on the proposed method.
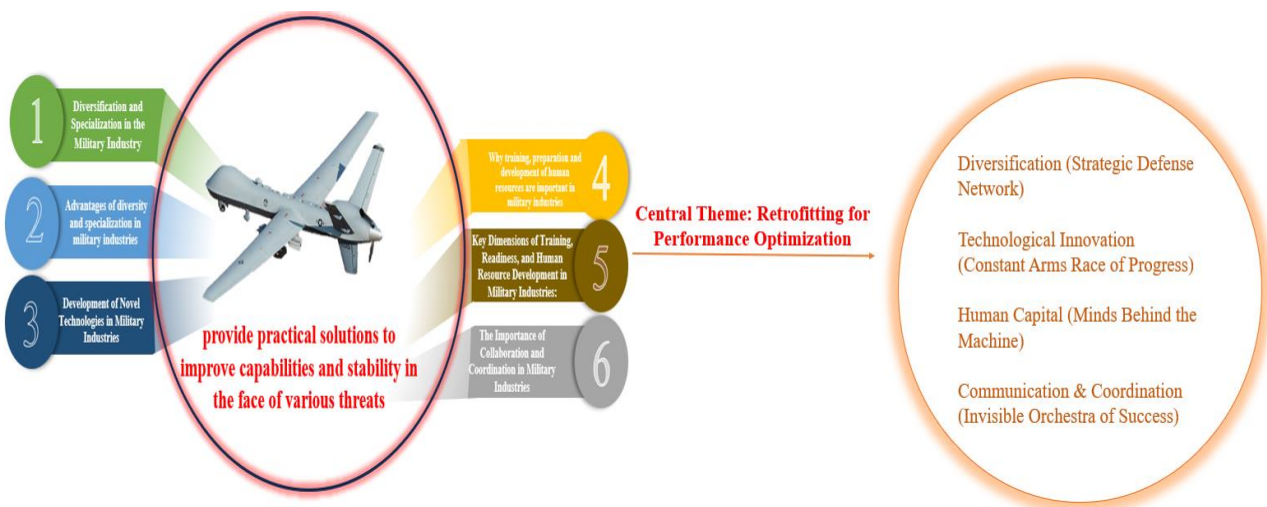

Figure 1. Graphic representation of the analysis process

3. Diversification And Specialization in The Military Industry

The military industry encompasses a wide range of specializations and diversities, which can be broadly categorized into two main areas:

3.1 Production of Military Components and Equipment:

This includes the production of various components and equipment required by the military, such as:

- **Electronic components:** Printed circuit boards, transistors, diodes, capacitors, resistors, etc.
- **Mechanical components:** Gears, bearings, springs, shafts, rods, etc.
- **Plastic components:** Body parts, enclosures, insulators, etc.
- **Metal components:** Sheets, bars, tubes, profiles, etc.
- **Military equipment:** Weapons, ammunition, communication systems, navigation systems, radar systems, optical systems, electronic warfare systems, etc.

Example: The United States Army utilizes automated and advanced manufacturing methods, such as 3D printing, to produce military components. This allows them to produce mechanical, electronic, and metal parts rapidly and efficiently, fulfilling their military requirements.

3.2 Research and Development [10]:

This involves research and development in various fields related to military technology, such as:

- **Materials:** Novel materials for the construction of weapons, equipment, and military systems.
- **Propulsion:** Advanced propulsion systems for aircraft, missiles, and other military equipment.
- **Weapons:** New weapons with enhanced accuracy and lethality.
- **Defence systems:** Advanced defence systems to counter various threats.
- **Information technology:** New information and communication systems for the military.

Example: The Defence Advanced Research Projects Agency (DARPA) was actively researched and new technologies, such as artificial intelligence, robotics, and cyberwarfare, were developed for the United States military.

4. Development Of Novel Technologies in Military Industries

Developing novel technologies in military industries is one of the proposed strategies for increasing effectiveness, defence, and resilience in military industries. These technologies include [11,12,13]:

4.1 Artificial Intelligence (AI):

Artificial intelligence in military industries improved decision-making capabilities, data detection and processing, simulation and modelling, automation and autonomous systems, and intelligent and automated systems.

For example:

One of the most prominent examples of artificial intelligence being used in military industries is Northrop Grumman. As a pioneer in the application of novel technologies, this American company utilizes artificial intelligence in the development and use of advanced military systems. Northrop Grumman employs AI algorithms to analyze complex data, predict enemy behaviour, enhance autonomous systems, and improve the performance of military equipment. The company extensively uses artificial intelligence to develop drones, advanced radar systems, and other military equipment. Table 1. Indicate the applications of AI technology in Military Industries.

Table 1. The Applications of Artificial Intelligence (AI) in Military Industries

Field of Application	Advantages	Sample Applications
Analysis and Threat Prediction	Increased accuracy and rate of Analysis	Predicting enemy attacks - Identifying and tracking targets
Planning and Guiding Military Operations	Enhanced efficiency and coordination	Planning and guiding drone operations - Logistics and procurement support
Control and Management of Drones and Robots	Improved precision and flexibility	Control and guidance of drones in combat operations - Navigation and maneuvering of robots in hazardous environments
Logistics and Procurement Support	Optimization and resource management	Predicting logistics needs - Managing procurement and transportation
Training and Simulation for Soldiers	Enhanced realism and effectiveness of training	War scenario simulation - Training in specialized skills

4.2 Robotics:

The use of robots and robotic systems in military industries was found to be effective in performing dangerous, hazardous, or repetitive tasks instead of humans. Robots were employed in military operations, reconnaissance of dangerous areas, transportation of cargo, and other tasks required in military industries. Table 2 indicates the applications of Robotics technology in Military Industries.

Table 2. The Applications of Robotics in Military Industries

Field of Application	Advantages	Sample Applications
Bomb and Mine Neutralization	Reduction of human risks and casualties	Bomb and mine neutralization - Identification and clearance of contaminated areas
Search and Rescue	Increased speed and accuracy of operations	Search for injured and missing the people on the battlefield - Rescue the people from hazardous areas
Equipment and Ammunition Transport	Enhanced operational capacity and flexibility	Transport of equipment and ammunition in the battlefield - Logistics support for units
Security Monitoring and Protection	Enhancement of security and protection	Monitoring and protection of borders and bases - Identification and tracking of infiltrations
Support in Combat Operations	Increased power and efficiency of units	Weapon and ammunition transportation - Artillery and mortar fire support

4.3 Optical and Laser Technologies:

The use of optical and laser technologies in military industries can be applied to military communications, information detection and analysis, precise measurement and guidance of systems, and other needs of military industries. These technologies are just a part of the technologies used in military industries and are constantly being developed and improved.

Laser illumination technology is one of the optical and laser technologies used in armies and military industries. This technology creates 3D maps of the environment for accurate data transmission and high-speed optical communications. Raytheon is a reputable company in optical and laser technology that uses this technology to develop advanced tracking and communication systems for armies. These systems provide high-speed, high-accuracy, and secure data

transmission and assist armies in communication and environmental monitoring.

One of the methods used in the training, preparation, and development of human resources in armies and military industries was the use of virtual training systems and augmented reality. These systems allowed for better training, more interaction, and simulation of combat and training situations and helped to improve the skills and abilities of the military. One of the case examples of using this method in the military industry was remote training through augmented reality systems, which had been used by the US Army for years to train its troops.

One of the case examples of the use of virtual training systems and augmented reality in the military was the US Army's use of the training system called "Integrated Visual Augmentation System (IVAS)", which used augmented reality technology as an advanced training tool for military training.

Table 3. Indicate the applications of Optical and Laser technologies in Military Industries.

Figures 2, and 3 show the drones developed with solutions mentioned for effectiveness and Resilience to enhance safety and reliability in aerospace & military industries.

Table 3. The Applications of Optical and Laser in Military Industries

Field of Application	Advantages	Sample Applications
Secure and High-Speed Communications	Exchange of information without the risk of eavesdropping	Communication between units on the battlefield - Secure information exchange with command
Precision Guidance of Weapons	Increased accuracy and range of weapons	Guiding missiles and bombs towards targets - Laser targeting for small-arms
Accurate Sensing and Navigation	Improved precision in positioning and navigation	Guiding drones and ships - Mapping and target location determination
Electronic Warfare	Creating disruption in enemy systems	Disruption of enemy communication and radar systems - Destruction of enemy electronic equipment
Night Vision Systems and Imaging	Enhanced visibility in darkness and adverse conditions	Surveillance and observation of enemies at night - Imaging of the battlefield

Figure 2. An example of drones manufactured by Northrop Grumman Co. that feature artificial intelligence technology, optical and laser equipment, imaging systems, and advanced sensors.

Figure 3. Updating aerospace industries using innovative technologies such as AI, the Internet of Things, and advanced outlook is crucial. For instance, Boeing's research on the unmanned aircraft Boeing MQ-25 Stingray

5. Why Training, Preparation and Development of Human Resources Are Important in Military Industries

The military industry is a complex and ever-evolving sector that is critical to national security. In today's rapidly changing world, military industries must constantly adapt to new technologies, threats, and challenges. To remain effective and efficient, these industries must invest in training, readiness, and human resource development.

Key Drivers for Training, Readiness, and Human Resource Development [14,15,16]:

5.1 Increasing Complexity of Military Technologies:

Modern military technologies have become increasingly complex and sophisticated. From electronic warfare systems and drones to missile systems and cyber warfare, the operation of these technologies requires specialized knowledge and high-level technical skills. Training and

development programs equipped personnel with the necessary knowledge and skills to work with these technologies and helped improve their efficiency and effectiveness.

5.2 Rising Security Threats:

The world faces various security threats, including terrorism, cyber warfare, and regional instability. Military industries require personnel with high physical and mental fitness, quick analysis and decision-making abilities, and strong combat and defence skills to counter these threats. Training and development programs strengthened These capabilities in personnel, preparing them to face the challenges ahead.

5.3 The Need to Maintain and Enhance Defensive Capabilities:

The defensive capability of each country was directly dependent on the capability and efficiency of its military industries. To maintain and enhance this capability, specialized, creative, and innovative human resources familiar with the latest military knowledge and technologies were needed. Innovation and creativity were focused on by training and development programs to help improve the country's defensive capabilities.

5.4 Increasing Resilience to Challenges:

Military industries face various challenges, including natural disasters, economic sanctions, and cyber-attacks. To deal with these challenges, there is a need for flexible, resilient, and high-spirited human resources who can operate effectively in crises. Training and development programs can help increase the sustainability and continuity of military industries in difficult times by improving the resilience and morale of their employees.

6. Key Dimensions of Training, Readiness, and Human Resource Development in Military Industries:

6.1 Training and Readiness:

- Specialized Technical Training: This includes training in various fields such as aerospace engineering, electronics, mechanics, and computer science.
- Practical Training includes field exercises, simulations, and manoeuvres to improve personnel's practical skills.
- Psychological Training: This includes improving resilience, stress management, and teamwork.
- Leadership and Management Training includes developing effective leaders and managers at various levels.

6.2 Technical Skills Development:

- Upgrading technical skills related to military technologies
- Training in data and information analysis
- Training in equipment and system maintenance
- Updating the knowledge and skills of employees in line with technological developments

6.3 Leadership and Management Skills Development:

- Training in leadership principles and techniques
- Team management and teamwork training
- Strategic decision-making training
- Resource management training

6.4 Knowledge and Research Development:

- Conducting basic and applied research in military technologies
- Data and information analysis

7. The Importance of Collaboration and Coordination in Military Industries

Collaboration and coordination between different stakeholders in the military industry are essential for increasing effectiveness, defence, and resilience. This can be achieved through various means, including [17,18,19,20]:

7.1 Information and Knowledge Sharing:

7.1.1 Transfer of Research and Results:

- Establishing comprehensive and secure systems for sharing research reports, findings, and inventions.
- Organizing specialized seminars and workshops for exchanging knowledge and experiences between researchers and experts.
- Awarding joint grants to universities and research centers to conduct projects related to the needs of military industries.
- Publishing scientific articles in specialized and reputable journals with international peer review.
- Creating digital libraries and knowledge repositories for easy access to information and knowledge.

7.1.2 Exchange of Experiences and Technical Knowledge:

- Creating human resource exchange programs between military industries and universities to transfer knowledge and practical experiences.

- Organizing specialized training courses to upgrade the technical knowledge of military industry personnel in various fields.
- Documenting and sharing the experiences and lessons learned from various military projects through reports, films, etc.
- Creating virtual networks for exchanging experiences and technical knowledge between experts.

7.1.3 Transfer of New Technologies:

- Establishing joint innovation and technology centers to develop and transfer new technologies to military industries.
- Supporting knowledge-based companies and startups in the production of equipment and technologies required by military industries.
- Investing in research and development of advanced technologies with military applications.
- Organizing technological events such as Startup Weekend to attract new and creative ideas.

7.2 Collaboration in Research and Development:

7.2.1 Conducting Joint Research Projects:

- Defining and prioritizing joint research projects based on the real needs of military industries.
- Allocating joint financial and human resources for research projects.
- Establishing evaluation and monitoring systems for the proper implementation of joint projects.
- Publishing the results of research projects in scientific and specialized forums.

7.2.2 Exchange of Human Resources and Equipment:

- Sending experts and researchers from universities and research centers to military industries to collaborate on research projects.
- Using the equipment and laboratory facilities of universities and research centers in military industry research projects.
- Creating opportunities for research visits and student exchange for greater interaction between universities and military industries.
- Organizing joint training courses to improve the level of knowledge and specialized skills.

7.2.3 Sharing Financial Resources:

- Establishing joint investment funds to support research and development projects.
- Providing financial facilities and incentives to attract private sector investment in research and development of military industries.

- Allocating government budgets to support research and development in areas related to security and defence.
- Attracting international financial assistance for joint research projects.

7.3 Creating Networks and Conferences:

7.3.1 Organizing Conferences, Seminars, and Joint Meetings:

- Creating opportunities for exchange of views and dialogue between experts and stakeholders in various fields related to military industries.
- Presenting the latest achievements and research findings in the fields of security and defence.
- Creating a platform for identifying and attracting elites and top talents to military industries.
- Organizing specialized exhibitions and events to showcase achievements.

7.3.2 Establishing Collaboration and Coordination Networks:

- Creating online systems to facilitate communication and information exchange between various stakeholders in military industries.
- Forming associations and specialized groups to exchange experiences and knowledge in specific fields.
- Organizing joint training courses to improve the level of knowledge and specialized skills.
- Creating knowledge management systems to collect, store, and share knowledge and experiences.

7.4 Determining Standards and Regulations:

7.4.1 Developing and Approving Technical Standards:

- Creating a single authority for developing and approving technical standards required by military industries.
- Coordinating with international bodies to align national standards with global standards.
- Monitoring the proper implementation of standards in military industries.
- Using international standards as a reference in developing and approving national standards.

7.4.2 Determining Safety and Quality Standards:

- Developing and approving safety and quality regulations to improve the safety and quality of products and services in military industries.

- Conducting the necessary tests and evaluations to ensure that products and services comply with safety and quality standards.
- Issuing safety and quality certificates to products and services that comply with standards.
- Creating supervisory systems for the proper implementation of safety and quality regulations.

7.5 Utilization of Facilities and Equipment:

7.5.1 Sharing Facilities and Equipment:

- Creating online systems for booking and sharing the required facilities and equipment of military industries.
- Signing cooperation agreements between military industries, universities, and government agencies for the shared use of facilities and equipment.
- Establishing joint centers for using specialized facilities and equipment.
- Updating and upgrading facilities and equipment to increase efficiency and productivity.

7.5.2 b) Developing and Equipping Infrastructure:

- Investing in the development and equipment of infrastructure needed by military industries.
- Establishing and equipping advanced laboratories and research centers.
- Developing and equipping training centers to improve the knowledge

8. Conclusion

This study highlights the importance of retrofitting strategies to enhance performance, defence capabilities, and resilience in the aerospace military industry. By focusing on these strategies, organizations can improve safety, reliability, and effectiveness in facing challenges and crises. Continued research and investment in retrofitting technologies and practices will ensure aerospace military industries' sustainable development and success.

The advantages of implementing proposed solutions and strategies are as follows:

- Increased capabilities: These solutions can help enhance the capabilities of various organizations and institutions in dealing with challenges and crises.
- Damage reduction: By implementing these solutions, it is possible to prevent human and financial losses resulting from crises.
- Acceleration of the return to normalcy: These solutions can expedite the process of returning to normalcy after a crisis.

Proposed strategies to enhance effectiveness, defence, resilience, and fortification in military industries include the following:

1) Industry diversity and specialization: Creating diversity and specialization in military industries, including the production of components, equipment, and various systems, can contribute to increased effectiveness and defence. This enhances the production, repair, and maintenance capabilities of military equipment.

2) Development of innovative technologies: Utilizing innovative and advanced technologies, such as artificial intelligence, robotics, the Internet of Things, and sensors, can help improve effectiveness and defence in military industries. These technologies can enhance military systems' performance, accuracy, and speed.

3) Research and development of infrastructures: A strong and stable infrastructure, including communication networks, energy, transportation, and water and food supply, can aid in increasing resilience and fortification in military industries. These infrastructures should have high reliability, resilience against attacks, and quick reconstruction capabilities.

4) Training and development of human resources: Training and developing specialized and experienced human resources, including military personnel and technical experts, can contribute to increased effectiveness and defence. This includes training in new skills, strengthening leadership capabilities, and developing technical knowledge.

5) Collaboration and coordination among relevant institutions and centers: Establishing collaboration and coordination among military industries, military forces, and other institutions and organizations can help enhance resilience and fortification. This collaboration may involve information exchange, joint project development, and joint exercises.

6) Analysis and evaluation of threats: Conducting a thorough analysis and evaluation of military threats and identifying weaknesses can help improve defence and resilience in military industries.

In this comprehensive review, we have investigated the multifaceted landscape of retrofitting strategies to optimise performance in military and aerospace systems. Our investigation covered critical and most important dimensions: diversification, technological innovation, infrastructure, human capital, and communication.

1) Diversification: By strategically diversifying capabilities, organizations fortify their defence networks. This adaptability ensures resilience against dynamic threats, enhancing overall safety and reliability.

2) Technological Innovation: The relentless arms race demands continuous progress. Cutting-edge advancements, from AI to robotics, drive military effectiveness and adaptability.

3) Infrastructure: Often overlooked, robust infrastructure is the unsung hero. It underpins mission success, reliability, and long-term performance.

4) Human Capital: Investing in training and development programs empowers the skilled workforce. Human resources are the linchpin of effective military operations.

5) Communication and Coordination: Seamless collaboration orchestrates success. Targeted cooperation ensures coordinated responses, contributing to overall effectiveness.

Moreover, we emphasize the advantages of diversity and specialization within military industries, the development of novel technologies, and the critical role of human resource readiness. As we navigate an ever-evolving landscape, effective collaboration remains paramount.

In summary, retrofitting strategies offer a pathway toward enhanced safety, reliability, and performance, ensuring that military systems remain resilient and effective in the face of evolving challenges. For example, psychological and communication training can be provided for military personnel on how to interact with unmanned aerial systems. For instance, the United States Air Force has demonstrated its capabilities in military operations by developing training programs for its personnel in strategic thinking and advanced. For instance, the U.S. Army utilizes virtual reality systems to train military helicopter pilots, significantly enhancing their performance and capabilities.

For example, one can point to the collaboration between the US military and top technology companies like Lockheed Martin or Boeing. These collaborations help transfer new technologies, such as drones and advanced aerospace equipment, and lead to improved performance and efficiency in the military industries.

Conflict of Interests

No conflict of interest has been expressed by the authors.

9. Reference

[1] M. H. MoghimiEsfandabadi, M. H. Djavareshkian, and S. Abedi, "Significance of Aviation Safety, Its Evaluation, and Ways to Strengthen Security," *International Journal of Reliability, Risk and Safety: Theory and Application,* vol. 6, no. 2, pp. 37-45, 2023, doi: https://doi.org/10.22034/IJRRS.2023.6.2.5.

[2] M. h. MoghimiEsfandabadi and M. H. Djavareshkian, "Maintenance Grouping Optimization with Air Systems to Improve Risk Management," *International Journal of Reliability, Risk and Safety: Theory and Application,* vol. 6, no. 2, pp. 85-91, 2023, doi: https://doi.org/10.22034/ijrrs.2023.6.2.10.

[3] M. H. Özdemir and G. Özkan, "Understanding Defense Industry: A Systems Thinking Perspective," *PERCEPTIONS: Journal of International Affairs,* vol. 26, no. 2, pp. 241-258, 2022. [Online]. Available: https://dergipark.org.tr/en/download/article-file/2181975.

[4] E. S. Medeiros, R. Cliff, K. Crane, and J. C. Mulvenon, *A new direction for China's defense industry*. Rand Corporation, 2005.

[5] S. I. Ivanov and B. C. Payne, "Analysis of The Portfolio Diversification Benefits of The Us Defense Industry Etfs," *International Journal of Finance,* vol. 24, no. 1, 2012.

[6] N. Hensel, "The defense industry: Tradeoffs between fiscal constraints and national security challenges," *Business Economics,* vol. 51, pp. 111-122, 2016, doi: https://doi.org/10.1057/be.2016.16.

[7] G. Friedman, *The next 100 years: a forecast for the 21st century*. Anchor, 2010.

[8] S. PW, "Military robots and the laws of war. The New Atlantis," ed, 2017.

[9] A. D. McAulay, *Military laser technology for defense: Technology for revolutionizing 21st century warfare*. John Wiley & Sons, 2011.

[10] M. T. Peters II, "Understanding Cyber Warfare: Politics, Policy and Strategy By Christopher Whyte and Brian Mazanec. New York: Oxford University Press, 2017.." *Journal of Strategic Security* 12, no. 3 (2019) : 175-178, doi: https://doi.org/10.5038/1944-0472.12.3.1765

[11] L. Concha Salor and V. Monzon Baeza, "Harnessing the Potential of Emerging Technologies to Break down Barriers in Tactical Communications," in *Telecom*, 2023, vol. 4, no. 4: MDPI, pp. 709-731, doi: https://doi.org/10.3390/telecom4040032.

[12] E. D. Kaplan and C. Hegarty, *Understanding GPS/GNSS: principles and applications*. Artech house, 2017.

[13] Y. J. Morton, F. van Diggelen, J. J. Spilker Jr, B. W. Parkinson, S. Lo, and G. Gao, *Position, navigation, and timing technologies in the 21st century: Integrated satellite navigation, sensor systems, and civil applications, volume 1*. John Wiley & Sons, 2021.

[14] R. Prasad and V. Rohokale, "Artificial Intelligence and Machine Learning in Cyber Security," in *Cyber Security: The Lifeline of Information and Communication Technology*, R. Prasad and V. Rohokale Eds. Cham: Springer International Publishing, 2020, pp. 231-247.

[15] M. Fayyazi *et al.*, "Artificial Intelligence/Machine Learning in Energy Management Systems, Control, and Optimization of Hydrogen Fuel Cell Vehicles," *Sustainability*, vol. 15, no. 6*,* p. 5249doi: https://doi.org/10.3390/su15065249.

[16] A. M. Zook, *Military competency-based human capital management: a step toward the future*. US Army War College, 2006.

[17] S. Frühling and S. Sinjen, *Missile defense: challenges and opportunities for NATO*. JSTOR, 2022. [Online]. Available: http://www.jstor.com/stable/resrep10371

[18] B. Schmitt, *From cooperation to integration: defence and aerospace industries in Europe*. Institute for Security Studies, Western European Union Paris, 2000.

[19] G. Satta, S. Esposito De Falco, L. Penco, and F. Parola, "Technological Alliances and Innovative Performance in the Aerospace and Defense Industry," *Strategic Change,* vol. 24, no. 4, pp. 321-337, 2015, doi: https://doi.org/10.1002/jsc.2013.

[20] V. Gervais, "Emerging technologies and the future of warfare," 2021.