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## Militarization of outer space: Do Automated Defense Systems (ADS) violate international space law?

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[tansif@live.com](mailto:tansif@live.com)<https://orcid.org/0000-0002-5454-2150>**Abstract**

*Militarization of outer space is very problematic, and more so with Automated Defense Systems (ADS)-autonomous detect and neutralize orbital menace technologies. These systems are taking place within the grey zone of regulations, which permits non-violent military operations and raises concerns regarding ethical and functioning dangers. The main problems are the loss of human control in the targeting option, which complicates the ethical decision-making process during the conflict, as well as the increased risks of space debris that may pose a threat to satellites and missions. ADS can also restrict the fair use of space to all countries, which creates geopolitical tensions and possible conflicts in orbit. This discussion identifies the weaknesses of current frameworks in dealing with the aspects of autonomy, accountability, and environmental impacts. It is a call to progressive bilateral accords to advance the concept of transparency, mitigation measures of debris, and verifiable protection so that outer space would be a place of peaceful discovery and collaboration in the face of increasing strategic tensions.*

**Keywords:** challenges, historical context, laws, opportunities, theoretical context

**Introduction**

The original definition of space was based on the principles of connectivity and exploration, which promoted collaboration across the globe. But it is fast turning into a military theater of superpower competition. States such as the United States, Russia, and China pay a lot of attention to orbital technologies and push their satellites out as watchdogs of space and high-tech devices (Rajagopalan, 2023). Important innovations involve Automated Defense Systems (ADS)- AI-based systems that automatically identify, monitor, and neutralize threats such as anti-satellite (ASAT) missiles or orbital debris (Robison, 2022). These systems also provide better protection of assets since they do not need human delays, and the space is vacant, creating a possibility of an immediate reaction (Newman & Cheney, 2023).

Nevertheless, such a change erases the distinction between defense and aggression, increasing the issue of stability and security. It questions the principles of fundamental international space law, namely the 1967 Outer Space Treaty (OST) (Carpanelli, 2024), which prohibits the use of nuclear weapons in space, but allows military operations, which are described as peaceful, in outer space (Robison, 2022). These regulatory loopholes allow uncontrolled ADS strikes that may become accidental or lead to cascades of debris, which is a serious impairment of access to space on a global scale (Carpanelli 2025).

The ASAT kinetic tests and the satellite cyberattacks have bolstered the distrust of spacefaring powers recently (Zilinskas & Marozas, 2022). It exchanges human control for machine control, and this increases risks because dual-use technologies such as lasers and interceptors are used to protect and to destroy. The collision risks are aggravated by orbital congestion, which transforms space into the precarious and disputed commons. The background of geopolitical conflicts should not ignore the necessity of introducing new norms and multilateral communication to protect decades of mutual advances against one erroneous decision (Inan-Simsek & Atvur, 2025; Sundahl, 2025).

### **Research Justification**

Militarizing outer space, which is further enhanced by technology, calls for a high level of scrutiny, with countries launching Automated Defense Systems (ADS) to occupy the orbital space. Space assets, which are inherent in global communications systems, navigation, and intelligence, are threatened in this transition to autonomous warfare, and this could sever international relationships. More recent intensifications, including the U.S.

Space Force plans and Russian anti-satellite tests augur ill for war in space. This research is critical to evaluate ADS compliance with space law, preventing a regulatory vacuum that may lead to an ecological and security catastrophe. The existing systems, the primary one being the 1967 Outer Space Treaty, are inadequate to control autonomy in defense systems and promote ambiguities in accountability and proportionality. Academic attention is still centered on the traditional weapons, with AI advances that blur human-robot lines being pushed into the background. Probing these interstices, this study combines legal theory with the emerging technologies, shedding light on ethical dilemmas such as the bias in algorithms in selecting targets and the growth of debris.

This paper has strongly advocated proactive governance in order to maintain space as a global commons. ADS proliferation is unchecked, and arms race and disastrous collisions are on the table, destroying peaceful endeavors as satellite dependencies explode. It makes it stronger by clarifying the possible contraventions to enhance multilateral efforts, transparency, and norms, which discourage orbital aggression and achieve sustainable space stewardship.

### **Research Objectives**

1. To discuss the historical context of the militarization of outer space and ADS.
2. To highlight the theoretical context of the militarization of outer space and ADS.
3. To analyze the laws regarding the militarization of outer space and ADS.
4. To identify the key challenges regarding the militarization of outer space and ADS.
5. To explore the opportunities for militarization of outer space and ADS.

6. To propose effective prevention and intervention strategies.

### Research Methodology

This study employed a systematic review methodology, with research objectives established accordingly. A comprehensive literature review was conducted (Komba & Lwoga, 2020). Research findings were categorized based on their content (Hiver et al., 2021; Petticrew & Roberts, 2006), and classified information was incorporated into the study by organizing it into headings (Gan et al., 2021; Pawson et al., 2005). The evaluation of classified information and titles formed the basis of the study (Page, 2021; Rahi, 2017), ensuring the integrity of the research subject and its contents (Egger et al., 2022; Victor, 2008). The criteria for selection are listed.

1. **Relevance:** Researches that directly addressed the questions posed by this study are included.
2. **Quality:** Studies that meet a certain quality threshold (e.g., methodological rigor, bias risk) are included. Most of the research is from Scopus-indexed and Clarivate Analytics journals and reputed publishers.
3. **Recency:** Consideration of the publication date to ensure that the review reflects the most current evidence. Most of the studies are from the last three years.
4. **Language:** Only studies published in English are included.
5. **Data Completeness:** Previous studies must provide sufficient data on outcomes of interest for practical synthesis; this is also ensured in this research.

This study did not use primary data from human participants; therefore, no ethics clearance letter from the ethics committee was required.

### Literature Review

The origins of scholarly discussion about the militarization of outer space can be traced back to the Cold War, and the initial talks analyzed the weakness of the 1967 Outer Space Treaty in preventing non-nuclear weapons. Literary works address military activities in space as an issue of international law, focusing on the dependence of the U.S. on satellites as a source of information and the uncertainty of the use-of-force standards. Research follows the trends of weaponization, with ASAT tests by China and the U.S. producing debris (Zilinskas & Marozas, 2022), posing the danger of Kessler syndrome as well as breaching the principles of peaceful use.

These highlight the ineffectiveness of the treaty in countering traditional militarization that promotes arms races in the backdrop of superpower competition. The more recent literature has been drifting to autonomous defense systems, which it presents as being an escalatory aspect of orbital warfare. Studies consider the intersection of AI-driven autonomy (Bratu & Freeland, 2025) and armed conflict law, saying private actors and space-based systems are problematic in regard to accountability. The use-of-force thresholds are examined in space, where reports propose that ADS would be allowed to facilitate damaging interference without clear violations (O'Meara, 2025). The legal consequences of autonomous weapons demonstrate disturbing meanings, as ADS obscures defensive and offensive actions in case it violates proportionality.

The shortcomings of the existing structures are clear, and a need to strengthen the existing treaties (Ortega & Koller, 2023) to reflect the new risks of ADS, such as debris and ethical autonomy, is desired. Research recommends restrictions on the ASAT systems and multilateral

standards to weaponize them and emphasizes the regulatory change to achieve sustainable use of space (Inan-Simsek & Atvur, 2025; O'Meara, 2025). This study will show through case studies and historical context, etc., that there is an agreement on legal obsolescence whereby doctrines need to reconcile security and peaceful exploration.

### **Historical Context of Militarization of Outer Space and ADS**

Militarization of outer space can be traced back to the times of the Cold War, during which the United States and the Soviet Union launched the first satellites to spy on their opponent and to warn about any missiles and transform orbit into a battle line (O'Meara, 2025). Space was considered a continuation of the power projection on the earth, and both superpowers considered satellites as a necessity of nuclear deterrence and intelligence collection. The preparation of non-weaponized systems was initially made, but the latent tensions blurred the exploration and espionage, which formed the basis of escalation (Muszynski-Sulima, 2023).

Anti-satellite (ASAT) tests have led to the acceleration of the militarization process after the Cold War: the U.S. obliterated Solwind in 1985 and China produced several thousand fragments of debris in 2007 (Muszynski-Sulima, 2023). The 2021 exercise by Russia escalated the alarm and posed a threat of Kessler syndrome, a sequence of collisions that makes the orbits unusable (Sankaran, 2022). The current wave of Automated Defense Systems (ADS) that emerged in the 2010s due to AI introduces the notion of autonomous neutralization, which compromises the peace-affirming human control of the treaty and reveals the unresolved ethical-legal dilemmas (Miller, 2021).

### **Theoretical Context of Militarization of Outer Space and ADS**

According to the realist theory, space militarization has been seen as the natural occurrence of the dilemma of state security, whereby states use the Automated Defense Systems (ADS) to defend themselves against threats in this anarchic space environment. Both states are based on the structural realism of Waltz, which emphasizes survival and considers space as the highest ground of the projection of power and dominance of intelligence. It is typified by ADS, which provides the benefit of autonomous preemption to the threat of anti-satellite (ASAT), but the technology sparks the spiral of escalation as both sides retaliate, disrupting the equilibrium of deterrence and increasing the zero-sum tussle in the arms race.

Liberal institutionalism provides an alternative, which proposes cooperative regimes in order to take advantage of interdependence. According to the regime theory developed by Keohane, regimes such as the Outer Space Treaty (OST) could be designed to govern ADS with the help of verification and confidence-building activities and make space a controlled global commons. Transparency norms could be imposed by multilateral forums and reduce the hazards of autonomy, including the UN Committee on the Peaceful Uses of Outer Space.

The approaches of constructivism emphasize the emphasis on normative construction, in which ADS legality is a result of the development of discourses concerning peaceful purposes. The social theory of Wendt states that threats are intersubjective; the framing of space into contested and cooperative conditions determines the understandings of international law. Answering the question of AI accountability is an ethical issue that leads to norm change, making ADS not a violation but a stewardship opportunity.

### Laws Regarding Militarization of Outer Space and ADS

The turn of outer space into a field of militarization has transformed it into a field of exploration into a possible superpower conflict. As countries implement AI-controlled Automated Defense Systems (ADS), the current international laws are failing to deal with autonomous and dual-use technologies. Legal frameworks are meant to bring about peace, but they need revision to curb the chances of conflict to maintain space as a global commons of cooperation.

**1. Outer Space Treaty (1967):** Bans any nuclear weapons and WMD in space, but permits peaceful use of space, and creates loopholes to conventional weapons, such as ADS.

**2. International Humanitarian Law (IHL):** Governs space wars, prohibiting attacks on civilian satellites or excessive force, although it does not provide special rules on autonomous systems, and thus threatens to spiral out of control.

**3. Moon Agreement (1979):** OST is applied to celestial bodies, and the declaration prohibits military bases and weapons testing, but its implementation is limited, which makes it less effective on the international level.

It is important to strengthen the international space law to counter the threat of militarization. The latest treaties and multilateral discussions are needed to avoid war, handle orbital crunch, and bring about sustainable access to space by the future generation.

### Challenges for Militarization of Outer Space and ADS

**1. Regulatory Loopholes:** The Outer Space Treaty permits the peaceful military purposes, but does not specify the autonomous systems, such as ADS, which can be weaponized freely, and the risk of accidental increment without renewed international standards.

**2. Orbital Congestion:** ASAT tests increase the amount of satellites and debris that can pose a collision threat, leading to Kessler Syndrome, where the cascading debris will effectively shut up space to every nation.

**3. Trust Erosion:** Superpower rivalries, such as cyberattacks and dual-use technologies, build up distrust, making it harder to do business, and triggering anxieties of preemptive attacks in an unstable orbital space.

**4. Technological Dual-Use:** AI-controlled defenses create confusion on the separation of protection and aggression, where lasers or interceptors are used in offensive purposes, instilling more geopolitical tension and collaborative efforts to use space.

### Opportunities for Militarization of Outer Space and ADS

**1. Technological Advancements:** Militarization through ADS stimulates innovative AI, satellite technology, and the use of dual-use technology such as lasers in civilian communities to improve communication, navigation, disaster management, and push the limits of autonomous functions to manage orbital space in an effective way.

**2. Strategic Security Improvements:** ADS offers a fast response to ASAT missiles and debris, which enhances national security and prevents aggression, which can stabilize geopolitical competitive interactions by providing space resources, assuring global intelligence, and the economy.

**3. Economic Growth:** Space militarization generates aerospace employment, spurs R&D, and creates markets in the exports of high-tech goods, bolstering industries that depend on satellites and creating international cooperation in the development of technology.

**4. Normative and Diplomatic Advancement:** Increased tensions promote the revision of existing treaties and multilateral negotiations, such as OST revisions, to establish peaceful uses, which foster transparency, mitigation of debris, and joint norms to turn rivalry into common governance to allow sustainable access to space

### Discussion

It is emphasized that there is a great conflict between Automated Defense Systems (ADS) and the Outer Space Treaty of 1967 (OST), which forbids nuclear arms, but permits, ambiguously, the peaceful deployment of such arms in relation to peace. ADS, their AI-driven agency, takes advantage of such ambiguity and could end up taking offensive measures in the name of self-defense, which would jeopardize a breach of Articles IV (weaponization prohibition) and IX (harmful interference).

Technologies such as lasers, which have dual purposes such as offense and defense, reduce the turnaround time of offense-defense, creating debris faster than the speed of ASAT tests and orbital congestion as observed in the 2007 and 2021 incidents in China and Russia, respectively. Although ADS improve security by preventing threats in the shortest time possible, they undermine the presence of human control, which makes issues of responsibility and the increase of autonomy in the war against humans controversial. Immediate reforms are needed: revised treaties, openness procedures, and controls are necessary to coordinate the information and communication technology development with the peaceful atmosphere in OST.

### Conclusion

ADS is attempting to contravene the 1967 Outer Space Treaty; they find loopholes in the peaceful case of military applications and may endanger prohibitions on weaponization and military interference. They can strengthen orbital security, but their independence could lead to worsening, proliferation of debris, and lack of trust during superpower competitions. This paper identifies regulatory loopholes in OST, IHL, and the Moon Agreement, calling for the regulations to respond to the ethics of dual-use technology and AI. To maintain space as a common good, multilateral updates, which are transparency protocols, ASAT bans, and verification mechanisms, are necessary. Proactive governance has the potential to match innovation to peaceful exploration and prevent an arms race and sustainable access to future generations.

### Recommendations

**1. Amend OST to ADS Clarity:** Revise the Outer Space Treaty to establish what ADS can and cannot be used to conduct, and explicitly prohibit the use of ADS on offensive capabilities to conform to the principles of peaceful uses.

**2. Install ADS Verification Systems:** Introduce sensors into ADS to monitor in real-time to control the adherence to international space treaties and to prevent unauthorized acts.

**3. Mandate SSA Data Sharing:** Oblige countries to disseminate Space Situational Awareness information through UNOOSA in order to help enhance transparency and mistrust among spacefaring nations.

4. **Ban Destructive ASAT Tests:** Introduce an international ban on Kinetic ASAT tests to minimize orbital debris, prevent other hazards like Kessler Syndrome.
5. **Repurpose ADS to Debris Mitigation:** Designate ADS technologies to be deployed to actively seek and remove debris, which is also in accordance with the OST idea of serving all countries.
6. **Build Defensive Standards:** Have a UN committee develop what is legitimate defensive ADS operations in order to end the misuse of vaguely defined standards of the OST.
7. **Rebuild PAROS with ADS Rules:** Rebuild PAROS with binding rules against ADS weaponization as a form of introducing gaps in OST regulation.
8. **Introduce Collaborative ADS Projects:** Launch multinational ADS programs to avoid collisions in space, with which to establish norms of peaceful space operations.
9. **Establish ADS Liability Protocols:** They need to develop frameworks to make states liable to autonomous ADS-related damages under the Liability Convention.
10. **Need Pre-Deployment Consultation:** Enforce OST Article IX consultations before deployment of ADS to help avert compliance and risks.

#### Research Limitations

This ADS study on space militarization is limited in a number of ways. Being a systematic literature review, it is based on published sources, which can be insufficient to capture classified ADS developments or real-time changes in geopolitics, and it might not be able to go in-depth with sensitive technologies. This omission of non-English materials may ignore the multinational views, especially of non-Western spacefaring countries. Reliance on secondary information limits the possibility of analyzing directly the effects of the ADS operation, including the impact of algorithms or the effects of debris.

The rapid development of AI and space technologies might render the discoveries obsolete, and they will have to be updated. The emphasis on state actors may be inadequate in regard to the increasing role of commercial actors in the governance of space. History learning, such as case studies, such as ASAT tests, cannot project future autonomous conflicts in a comprehensive manner. These limitations require careful interpretation and propose the addition of empirical, multi-lingual, and interdisciplinary methods.

#### Research Implications

1. **Policy Reform:** Discoveries recommend a modification of the Outer Space Treaty to control ADS autonomy to avoid an arms race by establishing binding norms on the dual-use technology and debris reduction.
2. **Legal Frameworks:** Highlight the new understanding of OST Articles IV and IX to tackle the accountability of AI to guide multilateral treaties to clear space governance.
3. **Technological Ethics:** Call attention to the necessity of ethical standards in ADS designing, include human control to correlate with IHL and minimize the danger of escalation.
4. **Diplomatic Efforts:** Reinforce UN-based talks on the mechanism of verification of activities, the encouragement of international collaboration to maintain space as a peaceful commons.
5. **Future Research:** Future research should investigate the effects of ADS on orbital sustainability and predictive models of conflict prevention.

### Future Research Directions

This study suggests that future studies on criminal justice ethics in Pakistan should consider some of these issues to solve the current problems and enhance the system.

1. **Corruption and Accountability Systems:** Exploring the efficiency of the existing anti-corruption systems and coming up with new strategies to improve accountability in law enforcement.
2. **Judicial Independence and Integrity:** Evaluating the degree of political meddling in the work of the judiciary and its influence on the decision of the case. Research could suggest remedies to improve judicial autonomy and come up with a structure to provide an unbiased approach in decision-making.
3. **The Right to Justice:** An examination of obstacles excluded communities encounter in seeking legal services and representation.
4. **Human Rights and Law:** An examination of human rights protection and its influence of the same in the criminal justice system. Research may be aimed at determining and solving systemic abuses and suggesting policies that may protect the rights of individuals in a more efficient manner.
5. **Integration of Culture and Religion:** The study of the integration of Islamic principles in the law and its impact on ethical practices.

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