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Automated Space Defense System (ASDS) - An Abomination for Space Law Treaties?

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Abstract
The use of Automated Space Defense Systems (ASDS) conflicts with the international space treaty (i.e., the 1967 Outer Space Treaty (OST) that prohibits the use of weapons of mass destruction and urges to use of space. The study will answer the question of whether Automated Space Defense Systems (ASDS) violate the provisions of the 1967 Outer Space Treaty and contribute to space militarization through a literature review, historical context, or case studies (i.e., US missile defense, Chinese Anti-Satellite, also known as ASAT tests), comparative analysis of dual-use technologies, and expert interviews. The study will help to explain the treaty compliance, uncover the threat of an arms race, and suggest solutions, including the transparency measures or new legal frameworks, to make sure that ASDS are consistent with the international law of space and that outer space is used in peaceful activities.

Keywords: Automated Space Defense System, Laws, Treaties, Theoretical Context

Introduction

ASDS uses such autonomous technologies as anti-satellite (ASAT) variants in defending space assets, which is the point of concern in the 1967 Outer Space Treaty (OST) (Cvetkovic & Drobnjak, 2023; Okoli & Nwankwo, 2025). The OST guarantees peaceful use of space and outlaws the weapons of mass destruction (Runnels, 2023), yet the bi-purpose that comes with ASDS creates ambiguities in terms of the OST compliance (O'Meara, 2025).

The Article IV of the OST bans nuclear arms in space but does not for conventional or autonomous devices, leaving gaps in the law to ASDS operations, the 2007 ASAT test by China and the 2021 test by Russia, whose debris was a threat to space debris, creating gaps in the law (Graham et al., 2024).

This study examines the Outer Space Treaty (OST), Prevention of an Arms Race in Outer Space (PAROS) resolutions, and other aspects of the matter to evaluate the legal aspects of Automated Space Defense Systems (ASDS) by using case studies and expert insights, it aims to clarify treaty compliance, address governance gaps, and propose measures to ensure peaceful space exploration.

Research Justification

The emergence of Automated Space Defense Systems (ASDS) has created a pressing need to conduct research because of the fact that they are likely to topple the 1967 Outer Space Treaty (OST). The OST, which centers on the ban of nuclear weapons, fails to regulate superior non-nuclear weapons such as the ASDS. They are dual-purpose and, therefore, the boundary between defense and illegal militarization is ambiguous, which is vulnerable to legal ambiguity. This study is necessary in order to cover these gaps in order to avoid an unregulated arms race in space.

The 2007 anti-satellite test of China, which produced a large amount of debris, demonstrates the dangers that ASDS can have on the space environment and geopolitical tensions. Article IV of the OST, which regulates peaceful use, does not have mechanisms for autonomous weapons systems. This study will examine these gaps and give recommendations on how treaty enforcement can be enhanced.

The study will assist countries to come up with ASDS that complies with treaty requirements and enhances peaceful utilization of space, civilian infrastructure, and space environment security. It is important to investigate on time to influence the development of effective legal, ethical, and governance standards that guarantee the sustainability and protection of space operations for everyone.

Research Objectives

1. To discuss the historical context of ASDS in relation to international space law.
2. To highlight the theoretical context of space law treaties, focusing on the 1967 Outer Space Treaty (OST).
3. To analyze the legal provisions regarding ASDS compliance with space law treaties.
4. To identify the key challenges regarding ASDS implementation and its impact on space militarization.
5. To explore the opportunities for aligning ASDS development with peaceful space use principles.
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 available knowledge on space law focuses on the 1967 Outer Space Treaty (OST) that outlaws the use of weapons of mass destruction in space and the peaceful utilization of space. Although it is a key institution in the regulation of space-based technologies, Runnels (2023) points out that it is outdated in the regulation of modern technologies such as the Automated Space Defense Systems (ASDS) that threaten the compliance of the treaty and the increasing militarization of space (Cvetkovic & Drobnjak, 2023). The compliance is complicated by the dual-use character of space technologies because, O'Meara (2025) believes, the line between defense and illegal militarization is becoming unclear with the help of ASDS.

It is reiterated by the fact that China conducted its ASAT test in 2007, which caused debris and heightened tensions. There is a continuous problem of enforcing space treaties. The urgent necessity of updated legal frameworks is mentioned by the case studies (US missile defense projects and Chinese ASAT testing) revealed (Pecujlic, 2023). Emerging technologies demand new legal frameworks that would not obstruct space to peaceful purposes.

Nevertheless, despite all this literature, there is still a gap in the literature specifically examining the legal implications of ASDS in the Outer Space Treaty (OST) (Robison, 2022; Wood, 2024), specifically the risk of non-compliance under Articles IX (harmful interference) and IV (weaponization). Although the principles of international cooperation and information sharing are still central to space governance (Chernykh & Volodin, 2023), and the principles of collaborative space activities have been introduced in such spheres, as on-orbit services, their implementation related to the ASDS transparency and arms race prevention has never been proposed. This study will fill this gap, building on the history of case study and scientific opinion to assess the compliance of ASDS, the risks of escalation, and ways to fix this gap to align the technical capabilities with sustainable space governance.

Historical Context of Automated Space Defense System

Space-based defense space development concept came into being during the Cold War, with the signing of the Outer Space Treaty (OST) in 1967. Although the OST banned nuclear weapons in orbit, it failed to deal with the conventional or autonomous defense systems directly (Cvetkovic & Drobnjak, 2023). The initial growth was focused on dual-use technologies, including the US missile defense program and the Soviet anti-satellite (ASAT) capabilities, which were defined as defensive mechanisms but had offensive capabilities as well (Petrova, 2023; Robison, 2022). All these loopholes in the OST are still posing a challenge to the control of contemporary Automated Space Defense Systems (ASDS) and are threatening to militarize (O'Meara, 2025).

The 21st century saw a fast militarization with a 2007 ASAT test by China (generating continuous debris) and a 2021 test by Russia. These events revealed the failure of the OST to control autonomous systems in Article IV (weaponization bans) and Article IX (harmful interference) - restrictions to the negotiated compromises in the treaty (Robison, 2022). There is no other explanation, as major powers explained ASDS development by the narratives of space domain awareness in the context of the intensification of geopolitical tensions. This trend shows the systematic failure observed by Robison (2022); the technological developments kept surpassing the legal frameworks based on the ambiguities of the OST. Geopolitical rivalries have halted diplomatic attempts to seal such gaps, allowing the ASDS to proliferate freely.

Theoretical Context of Automated Space Defense System

The interpretation of ASDS is conducted in terms of a theoretical framework that is characterized by the underlying controversy between technological development and a fixed jurisdictional system. The main limitation of the Outer Space Treaty is its very nature; by banning the use of machines of mass destruction in orbit, it has chosen not to regulate the use of conventional and autonomous systems when it was being drafted during the Cold War. This deliberate loophole left an unending gap in governance in which defensive technologies have offensive potential as a matter of course. This bi-purpose creates controversy theoretically:

1. The principle of peaceful purposes (Article I) of the treaty is interpretatively flexible with respect to systems that are sold as assets of the space domain awareness.
2. The weaponization ban of Article IV does not have systems to deal with autonomous targeting abilities.
3. The ban on harmful interference in Article IX has problems in defining algorithmic aggression.

Such tensions reveal a more profound theoretical problem: the state-centric structure of the OST is not able to regulate the mechanism when AI-driven platforms make decisions instead of human operators. The consequent gap in governance facilitates strategic discourses that legitimize the capabilities that cancer treaties prohibit. This normative gap between the legal superstructure of the Cold War and the autonomous technologies of the 21st century is the critical backdrop to analyzing the ASDS compliance, the threat of the arms race, and sustainable governance provisions.

Laws Regarding Automated Space Defense System

The legal framework of Automated Space Defense Systems (ASDS) is a complicated set of rules, with the main focus on the 1967 Outer Space Treaty (OST), which, despite its background relevance, has a high number of ambiguities concerning the modern autonomous systems.

1. Outer Space Treaty (OST) 1967: This is a foundation of international space law, which bans the use of mass destructive weapons in space and states the peaceful use of space. Nevertheless, Article IV does not speak of customary and independent defense mechanisms, and this presents a legal gap in ASDS deployment. The ban on harmful interference in Article IX does not have a clear definition of autonomous operations.

2. Prevention of an Arms Race in Outer Space (PAROS): Although such an initiative can help to tackle the problem of space weaponization, it does not yet include binding mechanisms directly related to ASDS, which also adds to the regulatory loopholes.

3. Lack of Prescriptive International Laws: There is also a significant gap in terms of the absence of specific international laws that will regulate autonomous space technologies, enabling big powers to take advantage of the weaknesses of the OST and run the development of ASDS in the name of self-defense.

Incidents such as the 2007 and 2021 Anti-Satellite (ASAT) tests by China and Russia reveal these loopholes. Therefore, it is necessary to revise legal frameworks and verification procedures to ensure that ASDS development is consistent with the peaceful exploration of space.

Challenges for Automated Space Defense System

1. **Arms Race Acceleration:** The unregulated growth and testing of ASDS by the key powers (e.g., China, Russia, US) contribute to geopolitical tension and encourage an arms race in space. It goes against the culture of peaceful exploration of the OST, adds a high amount of debris (as seen through ASAT tests), and risks global space security and civilian infrastructure.
2. **Dual-Use Dilemma:** ASDS itself tends to destroy the border between legitimate defense and outlawed militarization. They are equipped with offensive capabilities (e.g., ASAT capabilities), which are autonomous technologies that are disguised as space domain awareness and enable circumvention of treaties. It undermines the principles of the OST and increases the possibility of uncontrolled weaponization.
3. **Enforcement Weaknesses:** Existing space law does not have measures to ensure compliance with ASDS or respond to autonomous harmful acts (Article IX). The lack of binding laws and inspection procedures, indicated by unaddressed cases of such proliferation, such as the Chinese ASAT test in 2007, makes treaty enforcement ineffective to counter the ASDS proliferation.
4. **Legal Uncertainty:** There are no clear provisions governing conventional and autonomous defense systems such as ASDS in the 1967 Outer Space Treaty (OST). The issue of dual-use technologies leaves loopholes in compliance criteria that allow states to use defensive reasons to conceal offensive potential. This ambiguity goes directly against the very essence of the treaty of only peaceful use of space (Article IV).

Opportunities for Automated Space Defense System

1. **Adaptation towards Peaceful Uses:** ASDS technologies, such as the ability to target something precisely or monitor in space, can be reused as space debris cleanup or collision avoidance systems. It turns the defensive capabilities into orbital sustainability and safety tools, which directly contribute to the peaceful use of space that is required by international treaties.
2. **Development of Transparency structures:** ASDS implementation requires an increase in space situational awareness. It provides a chance to develop common international databases and collaborative surveillance programs, which can build trust and mitigate the possibility of misperception or the increase in spacefaring countries.
3. **Developing New Governance Models:** The formulation of self-determined space systems on particular peaceful objects in collaboration will provide a way to come up with binding international norms of autonomous space systems. This practice-based practice is also able to fill the legal gaps in existence and establish precedents of responsible behavior.
4. **Enhancing Checking:** ASDS is automated, which allows creating new compliance tools, like in-built sensors to monitor treaty commitments in real-time. It would establish powerful mechanisms to enforce compliance with prohibitions of damaging interference and weaponization.
5. **The Treaty Interpretation:** The flexibility existing in the principle of the Outer Space Treaty of the peaceful purposes is such that the legitimate uses of ASDS can be redefined. Defining some unequivocal and transparent rules of the defensive operations may match the original purpose of the treaty in the contemporary technological conditions.

Discussion

The discussion reveals that a fundamental clash exists between the Automated Space Defense Systems (ASDS) and the principles of the 1967 treaty on Outer Space (OST). Though ASDS are based on valid concerns in security, their dual-use character and independent functionality capitalize on the lack in the OST; specifically, Article IV lacks any reference to conventional weaponry, and Article IX does not specify the term harmful interference. It is a legal gap that means that defensive systems can conceal the offensive capability, and the militarization of space and the generation of debris, such as ASAT tests, can take place faster.

Nevertheless, there are ways to reinstate ASDS to peaceful intentions by reforming the interpretation of the treaty by adapting it, utilizing technology to reduce the debris, and establishing verification measures. This way forward requires immediate multilateral collaboration to set up binding norms, transparency mechanisms, and updated governance structures that can harmonize space technology with the OST mandate of ensuring that space remains a common, calm space.

Conclusion

The space Defense systems developed by automation are inherently defiant of the peaceful use principle of the 1967 Outer Space Treaty. Their dual-use character takes advantage of legal grey areas in Articles IV and IX, which allows militarizing space in the name of defense and increasing the risk of escalating the arms race. Although recycling ASDS to mitigate debris or creating verification systems provides opportunities to customize it to the treaty principles, the existing state of governance is hazardous. To maintain space as a common space, immediate multilateral

collaboration is required to develop binding mechanisms, transparency models, and updated legal frameworks to balance the autonomous technologies with the OST concept of the peaceful exploration upon which the vision of the foundation of this organization is built.

Recommendations

1. **Advance Dual-Use of Debris Mitigation:** Incentivize international cooperation in the repurposing of ASDS tracking and rendezvous technologies to active debris removal operations to match capabilities with OST Article I (benefit to all).
2. **Ban Destructive ASAT Testing:** Propose an international binding moratorium on destructive kinetic anti-satellite tests that produce long-lived debris, based on the case of the US unilateral ban, and with reference to the environmental urgency.
3. **Create ASDS-Specific Verification Regimes:** Formulate international technical standards that will have embedded sensors on the ASDS to monitor and verify treaty adherence (e.g., no offensive weaponization, compliance with standards of the mitigation of the effects of debris).
4. **Create Liability Measures to Autonomous Actions:** Design effective international liability and accountability standards under the Liability Convention for autonomous damages arising from ASDS, which hold the state responsible.
5. **Establish "Legitimate Defense" Standards:** Develop globally accepted standards with a UN COPUOS working group of what is considered to be legitimate defensive space operations and what should not be viewed as acts of aggression or destructive interference.
6. **Establish a PAROS Treaty with ASDS Provisions:** Revive the Prevention of an Arms Race in Outer Space (PAROS) program to incorporate formal legal prohibitions on the deployment and utilization of autonomous weapons systems in space, bridging the OST gap.
7. **Establish Fixed Diplomatic Consultations:** Initiate compulsory multilateral consultations as per OST Article IX, prior to deploying innovative ASDS strengths, and proactively discuss the issue to reduce risks and handle compliance issues.
8. **Introduce Prescriptive Peaceful ASDS Projects:** Introduce multinational pilot projects (e.g., collaborative ASDS-based collision avoidance networks) to show that it is being used responsibly and develop customary international norms of autonomous operation.
9. **Mandatory Multilateral Transparency Measures:** Compulsory data-sharing mechanisms on Space Situational Awareness (SSA) based on ASDS operations should be imposed by a neutral international organization, such as UNOOSA, to earn trust and avoid misunderstanding.
10. **Prepare a Supplementary Agreement to the OST:** Negotiate a binding supplementary agreement to the Outer Space Treaty with specific reference to autonomous space systems that will define what constitutes harmful interference (Article IX) and what are permissible defensive applications under the category of peaceful purposes.

Research Limitations

This study has several limitations inherent to it. This weakness can be seen in its conclusions as a systematic literature review because it is constrained by the number and quality of existing published literature, which may not sufficiently cover the legal implications of ASDS when operating under the OST, particularly in terms of autonomous operations. In case non-English materials are not included, significant regional perspectives can be overlooked.

Depending on secondary data, direct technical or geopolitical analysis of classified ASDS capabilities is restricted. Due to the rapid development of space technologies, part of the literature reviewed can already be outdated by new systems. Besides, the focus on state actors may be insufficient to reflect changes in the business sphere that significantly influence the governance of space. Case studies, e.g., ASAT tests, can provide the context, but they cannot effectively predict the compliance challenges that AI-driven systems will entail in the future.

Research Implications

1. **New Ways to Govern:** We desperately need new ways for countries to work together and manage these technologies. That means things like required transparency about what they're doing and ways to verify that everyone is following the rules about only using space for peaceful purposes. It will help prevent a space arms race.
2. **Smart Policies**: There is a need for giving decision-makers good, solid advice on how to balance national security and our responsibilities under international law. It could involve things like using anti-satellite weapons for good purposes, like removing space debris, or banning destructive anti-satellite tests altogether.

3. **Technical Guidelines**: It's crucial to create international guidelines for how anti-satellite weapons are built. These weapons should include built-in systems that monitor compliance and help reduce space debris. It would make it easier to ensure everyone is following the rules.
4. **Updating the Rules**: The Outer Space Treaty is getting old. There is a need for an update with additional agreements or clear interpretations to cover anti-satellite weapons specifically. It is especially important when it comes to how these weapons can operate on their own and what counts as "harmful interference" in space.
5. **What Happens Next?** Quite a number of things remain unknown. There is a need to conduct more research into issues such as accountability in case AI errors occur in space, the role companies must play, and the way to better forecast autonomous systems risks. It will assist us in coming up with more appropriate laws and knowledge in the future.

Future Research Directions

1. **AI Accountability Frameworks:** Explore the legal options to assign the liability of AI-driven ASDS when they result in harm to fit space operations within the Liability Convention to the models used to govern AI on earth.
2. **Global South Viewpoints:** Study non-Western visions of OST purposes of peace by region (e.g., Asia-Pacific space programs) in order to enlighten inclusive frameworks of governance.
3. **Predictive Metrics of Militarization:** Build quantitative models based on historic data of ASATs to predict the triggers of the arms race and heightened risks of treaty violation due to the emergence of ASDS in new capabilities.
4. **Role Analysis:** Commercial Sector Examine the role of commercial entities in the development and compliance of ASDS, evaluating the regulatory models of commercial autonomous systems in space.
5. **Technical Verification Protocols:** Design and prototype embedded sensor systems, real-time compliance monitoring by OST with AI-algorithm audits and verification of debris mitigation.

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