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Regulating the Use of High-Volume Loitering Munition

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Introduction

High-volume loitering munition, also known as suicide drone and kamikaze drone, refers to a type of missile with a warhead designed to track and locate an object, loiter above, and collide with the target, causing an explosion. Most loitering munitions, if accurately attacked, cause lethal destruction. Currently, there are no specific legislations regulating the use of loitering munitions, but their use must obey the International Humanitarian Law (IHL).

Figure 1: Loitering Munition, Defence Scoop

Many nations have developed high-volume loitering munitions with autonomous operating systems, which merge them under the category of lethal autonomous weapons systems (LAWS). Although the United Nations (UN) and the Convention on Certain Conventional Weapons (CCW) are pushing for stricter legislations on high-volume loitering munitions with autonomous systems, the progress is expected to be a gradual one, considering the consensus from states and the uncertainty in high-volume loitering munition systems.

The major concern caused by LAWS, including loitering munitions, is the incomplete research on autonomous and artificial intelligence (AI) operating systems. These systems lack accuracy and flexibility for adjustments, causing a high risk of unnecessary damages. Furthermore, loitering munitions could potentially put human safety at risk. It has occurred that loitering munitions caused civilian and military casualties, and some loitering munitions are programmed with anti-personnel profiles. For example, in June 2025, it is reported that loitering munitions have caused approximately 835 casualties, which is half of the total casualties in Ukraine during that month. Moreover, loitering munitions are not economically sustainable. Since most loitering munitions are single use, every strike is a cost spent whether the attack is successful or not. This also suggests less accessibility for less developed countries (LEDCs). Therefore, the use of loitering munitions must be regulated, for excessive use potentially violates IHL and human rights, as well as disrupting global stability.

Definition of key terms

Autonomous operating system

An autonomous operating system (AOS) refers to an advanced software system which enables unmanned aircrafts or devices to make decisions and actions based on real-time data and sensors, without human intervention.

Human-in-the-Loop

A human-in-the-loop system in LAWS refers to a cycle of human intervention and feedback in building, training, and testing an algorithm. LAWS with human-in-the-loop systems often require a human operator during a mission.

International Humanitarian Law

The International Humanitarian Law (IHL) is a set of rules which regulates and limits the impact of armed conflicts to protect individuals who are not or no longer involved in hostilities. It sets restrictions on certain weapons and war tactics to maintain human rights.

Lethal autonomous weapons systems

Lethal autonomous weapons systems (LAWS) refer to weapons, in this case aircrafts, which are capable of causing severe damage and operate with an AOS, meaning that no human operator is in control of the weapon during its mission.

Loitering munition

Loitering munitions refer to a type of missile with a warhead designed to track and locate an object, loiter above, and collide with the target, causing an explosion. Loitering munitions with an AOS are categorised under LAWS.

Unmanned aerial vehicles (UAVs)

Unmanned aerial vehicles (UAVs), also known as drones, refer to aircrafts without a human pilot. This suggests that loitering munitions also fall under the category of UAVs.

General Overview

Loitering munitions cause severe damage and disturbance to global stability, however, there is no specific regulation on loitering munitions, other than IHL. It is important to establish laws and frameworks to regulate the use of loitering munitions, especially in the modern context, due to the development of AOS, risk of human fatality, and the economic burdens.

AOS and AI Incorporated in Loitering Munitions

Reports have shown that, with the advances in AI, several countries have LAWS in use with complete AOS. A number of these AOSs incorporate more advanced navigation systems and assist the operator to better focus on the target by filtering out obstacles and distractions. The existing loitering munitions have AOS or AI involved to different extents, some operate completely autonomously, without any human intervention. An example of a completely autonomous loitering munition is the Israel Aerospace Industries Harpy (IAI Harpy). It operates with an AOS which allows the munition to be launched without the prior knowledge on the location of the target. The system allows the munition to determine the loitering area for the mission and can operate for a maximum of nine hours. Incorporated with an anti-radiation system, IAI Harpy is designed to locate objects emitting radiation. In other words, the IAI Harpy is designed to destroy radar systems.

An AOS incorporated with AI is capable of gathering real-time data to adjust and decide on their own. However, these decisions lack accuracy, flexibility, and are debatably unethical. For instance, the AOS of certain LAWS determines when to release force. There have been debates whether an AOS should be allowed to release force without permission from a human operator, since the algorithm is not completely capable of making ethical decisions. The secretary-general (SG) of the UN has urged for prohibiting LAWS with completely autonomous systems, as they are politically and morally unacceptable. Furthermore, other types of loitering munitions incorporate both human operation and AOS. Although these loitering munitions are more likely to reduce unwanted damage, research on AI incorporated systems is not complete, meaning there is still much uncertainty in when or how force is released.

Overall, although the use of AOS and AI in loitering munitions reduces human errors, it raises the concern of unethical decision-making done by algorithms. Observers have also suggested the possibility of certain AOS systems to operate beyond human control, which could lead to rapid escalations in conflicts. Many countries, such as China, the United States of America (USA), the United Kingdom (UK), Israel, South Korea, and Türkiye, have been reported developing autonomous loitering munitions, and global debates followed on whether AOS should be allowed.

Anti-personnel Profile and Targeting on Densely Populated Areas

In the early stages of developing loitering munitions, they were mostly designed to destroy objects. For example, the IAI Harpy was designed to locate and destroy radars. However, some recently developed loitering munitions were reported to target humans. According to an UN Human Rights report, “from 1 December 2024 to 31 May 2025” there was “a 37 percent increase in civilian casualties compared to the same period the previous year.” The report further discussed that loitering munitions and drones are “driving the rise in civilian casualties”.

Several countries reported loitering munitions with anti-personnel profiles or special use in densely populated areas. If these munitions are used in a conflict, they put civilian and civilian objects at risk of unlawful attacks. The action of targeting civilians is also a violation of IHL. Since it had been agreed that loitering munitions should be designed and used obeying IHL, it is certain that several of these munitions with anti-personnel profiles are unethical and unlawful.

An example is the STM Kargu-II from Türkiye. According to a report from the UN Panel of Experts on Libya in 2021, Kargu-II, which is completely autonomous, is designed with an anti-personnel profile, allowing the munition to select and engage human targets based on its machine learning classification. Although it is programmed to distinguish between civilians and military personnel, once the munition enters a heavily populated area, it is difficult to differentiate, putting civilian lives at risk. The report also suggested Kargu-II's violation of IHL, leading to enhanced social debate on whether AOS should be allowed.

Figure 2: Kargu-II, Lieber Institute West Point

Furthermore, the capacity of loitering munitions with anti-personnel profiles differs significantly.

The operation time of current munitions vary from fifteen minutes to six hours and a range of five to fifty kilometres. This is difficult for civilians to estimate the time and location of which the munition will release force, meaning that it is difficult to evade the explosion once the target is set. Reports have argued that this is evidentially unlawful towards civilian safety and livelihoods, and it is essential to push for a stricter framework on regulating loitering munitions in order to limit unlawful use and maintain civilian safety.

Economic Concerns of Loitering Munitions

Apart from concerns on ethics, loitering munitions also have economic disadvantages. Due to the design of detonating themselves close to the target, loitering munitions are single use, meaning that whether the target is hit or not, a munition is a cost spent. The cost of a loitering munition ranges from $20 million to $500 million, depending on its design. Currently, there are approximately ten countries with the capability of indigenously producing loitering munitions, with the leading countries being China, Israel, Russia, Türkiye, the UK, and the USA. Countries without the ability to produce loitering munitions independently are, therefore, in a position of disadvantage during a conflict.

Major parties involved

China

China's focus on loitering munitions has increased in recent years. It is one of the few countries with the ability to produce loitering munitions indigenously, with examples being the CASC CH-901 and the DFX-50 loitering munitions. Acknowledging the extensive use of loitering munitions in the recent Russia-Ukraine conflict, China has also ordered a million lightweight loitering munitions by 2026. Furthermore, the Chinese People's Liberation Army (PLA) has incorporated loitering munitions into their training programmes. The PLA has suggested that loitering munitions provide a "high cost-effective" solution for precise strikes.

Convention on Certain Conventional Weapons (CCW)

The CCW is a UN body established to regulate the use of weapons in order to maintain international security. In 2013, the CCW mandated LAWS, including high-volume loitering munitions. Due to observations on the emerging use of AOS and unlawful attacks, the CCW has pushed for regulating the use of LAWS. In 2024, the CCW established the Group of Governmental Experts on Lethal Autonomous Weapons Systems (GGE on LAWS) to further characterise and address the issue of LAWS with respect to IHL.

Group of Governmental Experts on Lethal Autonomous Weapons Systems (GGE on LAWS)

The GGE on LAWS was mandated by the CCW to further discuss and address the issue of emerging technologies surrounding LAWS. The GGE's meetings have discussed the topics of human intervention in LAWS, applicability of IHL, certain prohibitions on using LAWS, and obligations of states on using LAWS. Although the meetings have not yet resulted in an agreed upon solution, states have shown tendency to converge towards a two-tiered approach.

Iran

Since the Russia-Ukraine conflict, which proved the effectiveness of loitering munitions in battles, Iran has rapidly developed its loitering munitions. It has emerged as a loitering munition supplier to Moscow. Recently, Iran has announced its advances on its loitering munition Rezvan. Iran has further suggested that it will push for acquiring 1000 strategic drones in the near future. Furthermore, in the recent conflicts, Iran has launched loitering munitions towards Israel, causing civilian casualties.

Israel

Israel designed the first modern loitering munition system, the IAI Harpy, which was first tested in 1989. It was designed to destroy radar systems, and was sold to many countries, such as South Korea and China. In the recent Israel-Palestine conflict, loitering munitions have been a key component of the Israeli strategies. However, at the same time, Israel has reported civilian casualties due to loitering munitions used against Israel during the invasion of the Gaza Strip. Israel has addressed the danger of high-volume loitering munitions regarding their AOS and anti-personnel profiles, as well as the challenges of regulating them due to their ability to cause severe damage, precise strike, and cost efficiency.

Russia

In recent years, Russia has developed many loitering munition systems such as the ZALA Lancet and the V2U loitering munitions, which are incorporated with AOS, allowing precise strikes. In the recent Russia-Ukraine conflict, Russia has extensively used loitering munitions to target Ukrainian buildings, infrastructures, vehicles, and other high-value targets.

Ukraine

Inspired by the use of UAVs manufactured in China in 2014 of the conflict with Russia, Ukraine has developed its own system of loitering munitions and other LAWS. In the recent Russia-Ukraine conflict, Ukraine has used loitering munitions to destroy radars, missiles, and other war objects. Furthermore, several of the Ukrainian loitering munition systems are incorporated with AI, increasing its accuracy. However, similar to Russia, the use of loitering munitions has caused both civilian and military casualties.

USA

Recently, the USA has suggested its focus on developing loitering munitions to be incorporated in its strategies to seek precise strikes in complicated environments. The U.S. Army and Special Operations Command have suggested their focus on developing modern models of loitering munitions to improve speed and accuracy. They further suggested that loitering munitions have been engaged into their training programmes. Currently, the USA is also advancing in research on recoverable and reusable loitering munitions, such as the Teledyne FLIR Defence Rogue 1.

Timeline of events

1977 June 8th	The Protocol I Additional to the Geneva Conventions is created to protect victims of international armed conflicts. Article 36 discusses that states must determine whether new weapons, including loitering munitions, are designed and used in accordance with the rules of IHL.
1989	Israel tests the IAI Harpy loitering munition, the first modern loitering munition.
2014 May 13th	The CCW holds a meeting in Geneva, raising the issue of LAWS for the first time. The meeting addresses the concern of lack of human control and emerging AI use in UAVs.
2022 February 24th	The most recent Russia-Ukraine conflict begins. Ever since, both countries have been using loitering munitions in their strategies.
2022 March 7th	In the meeting of the GGE on LAWS, the two-tiered approach is suggested for the first time.
2023 October 7th	In the invasion of the Gaza Strip, Israel engages loitering munitions.
2024 April 14th	Iran launches UAVs, including loitering munitions towards Israel. However, these missiles fail to reach Israel.
2024 December 2nd	The General Assembly adopts a resolution on working towards the two-tiered approach in order to regulate the use of LAWS. It highlights the extensive use of LAWS during recent conflicts in Ukraine and Gaza.
2025 May 28th	The CCW and GGE on LAWS hold a meeting with High Contracting Parties (HCPs) and observers, discussing the issue of regulating loitering munitions under the IHL, surrounding the areas of human control, characterising LAWS, and anti-personnel profiles.

Possible solutions

Regarding the issues of high-volume loitering munitions, the UN has declared goals and held meetings towards solutions which circle around the applicability of the IHL, limiting AOS and AI, and reducing civilian harm. According to the United Nations Office for Disarmament Affairs (UNODA), since 2018, the SG of the UN has suggested that LAWS, including loitering munitions, are "politically unacceptable and morally repugnant" and has urged for their prohibition under the international law. In his 2023 New Agenda for Peace, the SG further recommended that States "conclude, by 2026, a legally binding instrument to prohibit lethal autonomous weapon systems that function without human control or oversight, and which cannot be used in compliance with international humanitarian law, and to regulate all other types of autonomous weapons systems." He also noted that "in the absence of specific multilateral regulations, the design, development and use of these systems raise humanitarian, legal, security and ethical concerns and pose a direct threat to human rights and fundamental freedoms." Since 2014, the CCW has been discussing a solution for LAWS. In the meetings with GGE on LAWS, several parties have agreed on pushing for a two-tiered approach, and most parties suggested the importance of aligning with the IHL. Furthermore, recent research has shown the potential of recoverable loitering munitions.

Application of the IHL

The CCW has discussed the characterisation of high-volume loitering munitions. The IHL categorises loitering munitions under "Autonomous Weapon Systems, Drones and Unmanned Aerial Combat Vehicles (UACVs)". It is important to note that, although loitering munitions are drones and UACVs, not all are LAWS, since some loitering munitions do not have an AOS. IHL strives to protect human rights in international conflicts and from certain weapons. It specifies and limits the production, stockpiling, transfer, and use of weapons. The major rules of IHL most relevant to loitering munitions are that:

1. Weapons used in a conflict must be able to distinguish between military and civilian targets.
2. During attacks, parties of a conflict must take precautions to limit the potential effects of weapons on civilians and civilian objects.
3. Weapons with the nature of causing superfluous injuries or unnecessary suffering are prohibited.
4. Weapons with indiscriminate natures are prohibited.

Thus, it is essential for states to supervise and control their loitering munitions, ensuring the munitions are designed, produced, and used under the IHL.

However, there are debates regarding whether supervision is necessary in *all* stages to comply with the IHL. in the meeting of the CCW on May 28th, 2025, the Chair and the Ambassador of the Netherlands raised the guiding question of whether direct control and oversight during the selection and engagement stages of the target is always necessary to ensure following the IHL. Several states suggested that it is not necessary, since the control is usually done before selecting and engaging the target. They further emphasised the importance of human supervision and control during developing the weapon in order to comply with the IHL. Furthermore, states have also suggested other methods to ensure the alignment with the IHL apart from direct control and oversight, such as limiting the target types and operation range. On the other hand, some states believe that human control and oversight should be involved in all stages of designing, producing, and using loitering munitions. Despite the differences in opinions, states have agreed that it is essential to ensure the designing, production and use of loitering munitions should obey the IHL, and emphasised the need for more specific frameworks regarding how to supervise these aspects.

The Two-tiered Approach

In the GGE on LAWS meeting from March 7th to 11th, 2022, the two-tiered approach was first proposed. It seeks to "(1) prohibit LAWS that can be operated without human control, while (2) regulating the design and use of autonomy in weapon systems, including through safeguarding human control and ensuring that the use of force remains predictable and understandable." *(Ingvild Bode, 2023)* This suggests that loitering munitions with completely autonomous systems are not allowed, and that a human-in-the-loop process should be ensured in the developing and training stages. It further suggests that a human operator is needed when the loitering munition releases force. By applying this solution, the concern of irresponsible or unethical decision-making done by algorithms is solved, while allowing AI assistance for human operators to increase accuracy.

In recent meetings of the GGE on LAWS, increasingly more states have shown tendency to support the two-tiered approach. However, it is impossible to neglect the weaknesses of this solution. For example, "ensuring that the use of force remains predictable and understandable" contains much room for debate on the clarity and definition of "predictable and understandable". It is difficult to define whether an attack is comprehensive and responsible simply because it is under human control. Furthermore, the two-tiered approach does not address the concerns of harming civilians raised by anti-personnel loitering munitions. Therefore, it is seen that nations are gradually converging towards the two-tiered approach. Yet, some parties argue whether this is an effective solution.

Recoverable Loitering Munitions

Apart from the political and ethical concerns of loitering munitions, the cost-effectiveness is also questionable. Although the cost of loitering munitions is not high compared to other weapons, its nature of single use suggests its economic ineffectiveness. However, research has shown the potential of recoverable or reusable loitering munitions.

On April 28th, 2025, the Teledyne FLIR Defence announced the research progress on recoverable and reusable loitering munitions. They suggested that their new loitering munition unmanned aircraft system (LMUAS) are more cost-effective. LMUAS is suited for operating in the atmospheric littoral zone, which means low-altitude airspace that is several hundred metres above the ground. Furthermore, FLIR Defence suggested that the LMUAS recoverable loitering munitions are simpler to train and programme, and that they can be safely brought back if the mission changes.

For example, according to FLIR Defence, the Rogue 1 loitering munition is an "optionally-lethal" UAV which contains a "mechanical interrupt that allows the aircraft to be safely recovered and reused when targets are disengaged or missions are aborted." Compared to other loitering munitions, which are not reusable whether the target is hit or not, the Rogue 1 is much more cost-effective and sustainable.

Figure 3: Rogue 1, Teledyne FLIR Defence

However, recoverable or reusable loitering munitions do not solve the problem or the potential for an international arm race. Although the cost-effectiveness could be increased by this technology, not all countries process the ability to design and produce loitering munitions locally. Thus, the question which remains is global interdependence and competition among countries in the design and manufacture of loitering munitions, and how it will influence the country's political status and ability in international conflicts. Although high-volume loitering munitions are a significant technological and political advance, their ethical and social concerns await an internationally agreed solution to reinforce global stability and civilian livelihoods.

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