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## **Artificial intelligence and autonomous weapons in armed conflicts: Implications for compliance with international humanitarian law**

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**Summary:** 1. Introduction. 2. Methodology. 2.1. Conceptual framework and typology of technologies. 3. Results and discussion. 3.1. Results. 3.2. Discussion. 4. Conclusions. 5. References.

**Abstract:** The study aims to analyse the dynamics of the use of autonomous systems, artificial intelligence technologies, and cyberattacks in armed conflicts in 2015–2024. The paper also identifies their impact on compliance with international humanitarian law. A normative analysis of the provisions of the Geneva Conventions, UN documents, the ICRC, and the Group of Governmental Experts (GGE) applied. The empirical part was based on SIPRI, UCDP, and ACLED data. The main emphasis was placed on the analysis of indicators during 2021-2024. These data served as the basis for conducting correlation and regression analysis. The results revealed the relationship between the level of technological participation and the number of violations of IHL ( $r = 0.80$  for cyberattacks;  $r = 0.65$  for autonomous systems). The highest humanitarian risks are recorded in wars with high lethality and fragmentation rates (Ukraine, Syria, Sudan, and Israel). Hence, the technological evolution of war has formed important legal gaps in the regulation of autonomous and cyber means. Existing IHL norms need to be updated by establishing the principle of "meaningful human control".

**Keywords:** International Humanitarian Law, Autonomous Systems, Cyberattacks, Technological Warfare, Violations Of Ihl, Humanitarian Risks

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**Resumo:** El estudio tiene como objetivo analizar la dinámica del uso de sistemas autónomos, tecnologías de inteligencia artificial y ciberataques en conflictos armados entre 2015 y 2024. El documento también identifica su impacto en el cumplimiento del derecho internacional humanitario. Se aplicó un análisis normativo de las disposiciones de los Convenios de Ginebra, documentos de la ONU, el CICR y el Grupo de Expertos Gubernamentales (GGE). La parte empírica se basó en datos de SIPRI, UCDP y ACLED. El énfasis principal se puso en el análisis de indicadores durante 2021-2024. Estos datos sirvieron de base para realizar análisis de correlación y regresión. Los resultados revelaron la relación entre el nivel de participación tecnológica y el número de violaciones del DIH ( $r = 0,80$  para ciberataques;  $r = 0,65$  para sistemas autónomos). Los mayores riesgos humanitarios se registran en guerras con altas tasas de letalidad y fragmentación (Ucrania, Siria, Sudán e Israel). Por lo tanto, la evolución tecnológica de la guerra ha generado importantes lagunas jurídicas en la regulación de los medios autónomos y cibernéticos. Es necesario actualizar las normas vigentes del DIH, en particular estableciendo el principio del «control humano significativo».

**Palavras-Chave:** Derecho Internacional Humanitario, Sistemas Autónomos, Ciberataques, Guerra Tecnológica, Violaciones Del Dih, Riesgos Humanitarios

## 1. Introduction

Modern armed conflicts are defined by technology. Accordingly, the introduction of autonomous weapons systems, artificial intelligence and cyber assets has an impact on the formation of new complex challenges for international humanitarian law (IHL). These technologies have changed the nature and scale of wars and even violate the fundamental principles of IHL—distinction, proportionality and humanity.<sup>2</sup> The ability of autonomous systems to make decisions without human intervention, as well as the use of cyber weapons, which can affect the destruction of critical infrastructure far beyond the combat zone. Accordingly, this also complicates the protection of civilians.

The use of modern autonomous technologies is the subject of active discussion in the field of international law. Several modern studies point to the lack of human control in the decision-making process of autonomous systems.<sup>3,4</sup> Modern authors have pointed out that such systems may not comply with IHL principles. The study by Anderson & Waxman provided a broader discussion of this issue. The authors pointed out that the future development of autonomous weapons systems is a topic of intense public debate. Some concerned critics present this future—often with science fiction imagery—as a straightforward choice between a world where these systems are completely banned and one where there are a legal vacuum and moral decay on the battlefield.<sup>5</sup> The authors also identified that a complete ban on autonomous weapons systems would replace any potential dangers of such systems

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<sup>2</sup> CHIAPPINI KOSCINA, Valeria. Prosecuting Killer Robots: Allocating Criminal Responsibilities for Grave Breaches of International Humanitarian Law Committed by Lethal Autonomous Weapon Systems. *Law and Artificial Intelligence*. The Hague: T.M.C. Asser Press, 2022, p. 149–167. [https://doi.org/10.1007/978-94-6265-523-2\\_8](https://doi.org/10.1007/978-94-6265-523-2_8)

<sup>3</sup> BIERSTEKER, Erwin; et al. Humanitarian support in a denial of access context: emergent strategies at the interface of humanitarian and sovereign law. *Journal of International Humanitarian Action*, 2021, vol. 6, no. 1. <https://doi.org/10.1186/s41018-021-00103-w>

<sup>4</sup> BATTISTUZZI, L.; RECCHIUTO, C. T.; SGORBISSA, A. Ethical concerns in rescue robotics: a scoping review. *Ethics and Information Technology*, 2021, vol. 23, no. 4, pp. 863–875. <https://doi.org/10.1007/s10676-021-09603-0>

<sup>5</sup> ANDERSON, K.; WAXMAN, M. C. Law and Ethics for Autonomous Weapon Systems: Why a Ban Won't Work and How the Laws of War Can. *SSRN Electronic Journal*, 2013. <https://doi.org/10.2139/ssrn.2250126>

in combat.<sup>6</sup> Hellman, who studied the impact of artificial intelligence and autonomous weapons, made a valuable conclusion that current international rules are not effective in addressing the challenges posed by the development of military technologies.<sup>7</sup> Other authors have pointed to several ethical problems with the use of such weapons, both in practice and in law.<sup>8</sup>

Moreover, the process of using new technologies in armed conflicts should be based on fundamental documents of international law. First of all, this is the Charter of the United Nations, which defines the principles of maintaining international peace, security and limitation of force in interstate relations.<sup>9</sup> At the same time, the provisions of the 1949 Geneva Conventions remain key in the field of protecting victims of war.<sup>10,11</sup> But their norms do not sufficiently take into account the specifics of digital and autonomous weapons systems, which creates gaps in law enforcement. International views of leading international institutions provided annual reports emphasize new challenges related to the automation of combat systems, the need for transparent arms control and the updating of international accountability mechanisms.<sup>12</sup> In scientific works, the use of artificial intelligence is an important topic of discussion in the context of armed conflicts. Most researchers raise concerns about the rapid development of this technology and its impact on society.<sup>13</sup> The study by Kochupillai et al. analysed in detail some of the risks associated with the lack of legal liability for AI actions in conflict zones.<sup>14,15</sup> The question of their compliance with key humanitarian principles

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<sup>6</sup> BILLER, J.; GOINES, T. *Protecting Civilian Data in Armed Conflicts. Ethical Dilemmas in the Global Defense Industry*. New York: Oxford University Press, 2023, pp. 189–216. <https://doi.org/10.1093/oso/9780190675813.003.0008>

<sup>7</sup> HELLMAN, J. *The Impact of Autonomous Weapons Systems on Armed Conflicts: Are International Humanitarian Law Norms Offering an Adequate Response? Contributions to International Relations*. Cham: Springer Nature Switzerland, 2024, pp. 155–172. [https://doi.org/10.1007/978-3-031-66750-3\\_10](https://doi.org/10.1007/978-3-031-66750-3_10)

<sup>8</sup> ENGELHARDT, W.; KESSLER, V. The ethical debate about the use of autonomous weapon systems from a theological perspective. *Verbum et Ecclesia*, 2024, vol. 45, no. 1. <https://doi.org/10.4102/ve.v45i1.3176>

<sup>9</sup> UNITED NATIONS GENERAL ASSEMBLY. *Charter of the United Nations and Statute of the International Court of Justice*. New York: UN, 1945. Available at: <https://www.un.org/en/about-us/un-charter> (accessed on 15 November 2025).

<sup>10</sup> CONVENTION (IV) RELATIVE TO THE PROTECTION OF CIVILIAN PERSONS IN TIME OF WAR. Geneva, 12 August 1949. *International Humanitarian Law Databases*. Geneva: International Committee of the Red Cross. Retrieved 25 February 2025. Available at: <https://ihl-databases.icrc.org/en/ihl-treaties/gciv-1949> (accessed on 15 November 2025).

<sup>11</sup> ADDITIONAL PROTOCOL I to the Geneva Conventions of 12 August 1949. Protocol I relating to the Protection of Victims of International Armed Conflicts. Geneva: ICRC, 1977. Available at: <https://ihl-databases.icrc.org/en/ihl-treaties/api-1977> (accessed on 15 November 2025).

<sup>12</sup> STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE (SIPRI). *Armaments, disarmament and international security*. Stockholm: SIPRI, 2023. Available at: <https://www.sipri.org/yearbook/2023> (accessed on 15 November 2025).

<sup>13</sup> JOHNSON, J. Artificial intelligence & future warfare: implications for international security. *Defense & Security Analysis*, 2019, vol. 35, no. 2, pp. 147–169. <https://doi.org/10.1080/14751798.2019.1600800>

<sup>14</sup> KOCHUPILLAI, M.; KAHL, M.; SCHMITT, M.; TAUBENBOECK, H.; ZHU, X. X. Earth Observation and Artificial Intelligence: Understanding emerging ethical issues and opportunities. *IEEE Geoscience and Remote Sensing Magazine*, 2022, vol. 10, no. 4, pp. 90–124. <https://doi.org/10.1109/mgrs.2022.3208357>

<sup>15</sup> YURYK, Olha et al. Assessment of the Impact of Artificial Intelligence Technologies on the Development of Ukrainian Medicine in War Conditions. *International Journal of Chemical and Biochemical Sciences*, 2023, vol. 24, no. 5, p. 206–211.

remains open.<sup>16,17</sup> In addition, scholarly works point out that cyber weapons and, in some cases, AI have an impact on violations of the fundamental principles of IHL the prohibition of attacks on civilian infrastructure.<sup>18,19</sup> Some studies have also pointed out that cyber operations are particularly devastating for civilians, even when they are not directed solely at military objectives.<sup>20</sup> Therefore, this review of the available scientific literature has shown that there are significant legal gaps in the use of autonomous weapons that require revision and adaptation of existing IHL rules. In addition, despite the growing threat, the use of cyber disruption also remains incompletely regulated. These gaps require a systematic approach to addressing these issues.

Despite recent discussions within the UN, the International Committee of the Red Cross (ICRC) and the Group of Governmental Experts (GGE), the existing system of international humanitarian law largely reflects the logic of the era of traditional wars.<sup>21,22</sup> That is, it does not fully take into account the specifics of new technological threats and the moral and legal dilemmas associated with them. In addition, previous scientific works are mainly aimed at theoretical understanding of the consequences of the use of autonomous systems. However, there are significant gaps in the quantitative analysis of the real impact of these technologies on compliance with IHL. It is worth pointing out the confirmed connection between the level of use of autonomous and cyber systems in conflicts and the number of recorded violations of humanitarian law. That is why this work is aimed at combining legal analysis with quantitative methods and studying trends for 2015–2024, analyzing international documents. The chosen approach will make it possible to identify existing patterns between technological development and violations of IHL and point to the importance of current international legal norms. Therefore, the aim of the study will be to show the relationship between the level of use of new technologies in armed conflicts (autonomous systems, artificial intelligence and cyber assets) and the number of recorded violations of international humanitarian law

Research objectives: (1) To indicate the dynamics of the use of autonomous systems, artificial intelligence technologies, and cyber assets in armed conflicts; (2) To determine the relationship between the level of technological participation in

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<sup>16</sup> GARCIA, D. Lethal Artificial Intelligence and Change: The Future of International Peace and Security. *International Studies Review*, 2018, vol. 20, no. 2, pp. 334–341. <https://doi.org/10.1093/isr/viy029>

<sup>17</sup> GELLERS, J. C.; GUNKEL, D. J. Artificial Intelligence and International Human Rights Law: Implications for Humans and Technology in the 21st Century and Beyond. In: *Handbook on the Politics and Governance of Big Data and Artificial Intelligence*. Cheltenham: Edward Elgar Publishing, 2023, pp. 430–455. <https://doi.org/10.4337/9781800887374.00027>

<sup>18</sup> ONIANI, D.; HILSMAN, J.; PENG, Y.; et al. Adopting and expanding ethical principles for generative artificial intelligence from military to healthcare. *NPJ Digital Medicine*, 2023, vol. 6, art. 225. <https://doi.org/10.1038/s41746-023-00965-x>

<sup>19</sup> TRACH, Yuliia et al. Problems of Cultural Heritage Preservation in the Context of the Armed Conflict Growth. *International Conference on Information Technology in Disaster Risk Reduction*. Cham: Springer International Publishing, 2020. p. 31-44. [https://doi.org/10.1007/978-3-030-48939-7\\_4](https://doi.org/10.1007/978-3-030-48939-7_4)

<sup>20</sup> TSILONIS, V. Lethal Autonomous Weapons, Drones and Robots: To What Extent Their Usage Infringes Upon Established Principles of International Criminal Law? In: *The Jurisdiction of the International Criminal Court*. Cham: Springer International Publishing, 2024, pp. 299–314. [https://doi.org/10.1007/978-3-031-46138-5\\_11](https://doi.org/10.1007/978-3-031-46138-5_11)

<sup>21</sup> SHERESHEVSKY, Yahli. International humanitarian law-making and new military technologies. *International Review of the Red Cross*. 2022, 104(920-921), 2131–2152. <https://doi.org/10.1017/S1816383122000443>

<sup>22</sup> DUMANSKA IY, et al. Personal data protection policy impact on the company development. *WSEAS transactions on environment and development*, 2022, vol. 18, p. 232-246. <https://doi.org/10.37394/232015.2022.18.25>

wars and the number of recorded violations of international humanitarian law; (3) To determine the importance and relevance of existing international legal norms and official documents (UN, ICRC, GGE) within the framework of technological evolution.

This article examines the impact of autonomous and digital military technologies on compliance with international humanitarian law in contemporary armed conflicts. The analysis focuses on the application of the fundamental principles of IHL, distinction, proportionality, precaution and responsibility, in the context of the use of autonomous systems, unmanned platforms and cyber operations. Issues of criminal procedure, pre-trial investigations, evidence and procedural standards are beyond the scope of this study and are not its purpose.

## 2. Methodology

The research was implemented based on a mixed type, which involved a combination of normative and legal and empirical data analysis. The chosen approach made it possible to indicate the role of theoretical legal norms (in particular, norms of international humanitarian law) and practical trends in the use of new military technologies (drones, autonomous systems, cyber operations).

The normative part provides for an analysis of the main international acts, in particular the main provisions of the Geneva Conventions of 1949 and their Additional Protocols. Key documents were also selected for analysis: the International Committee of the Red Cross (ICRC) and the UN Group of States Experts on Lethal Autonomous Weapons Systems (GGE) on autonomous weapons.<sup>23,24,25,26</sup> This part aimed to identify the main legal gaps in regulating the use of autonomous weapons systems, unmanned aerial vehicles and cyber weapons in armed conflict.

The empirical part consisted of three interrelated components:

(1) Trend study of the use of technologies. This part provides for the collection and processing of data on the number and frequency of use of unmanned aerial vehicles (UAVs), autonomous weapon systems and cyber operations in armed conflicts for the period 2015–2025. The main sources of data were reports from the Stockholm International Peace Research Institute – SIPRI and the Uppsala Conflict Data Program – UCDP).<sup>27,28</sup> The purpose of this stage was to show the growth of technological use in military operations.

<sup>23</sup> INTERNATIONAL COMMITTEE OF THE RED CROSS (ICRC). *Autonomous weapon systems: Implications of increasing autonomy in the critical functions of weapons*. Geneva: CRC, 2023. Available at: <https://www.icrc.org/en/publication/4283-autonomous-weapons-systems> (accessed on 15 November 2025).

<sup>24</sup> INTERNATIONAL COMMITTEE OF THE RED CROSS (ICRC). *International Humanitarian Law and the Challenges of Contemporary Armed Conflicts: Report to the 34th International Conference*. Geneva: ICRC, 2019. Available at: <https://international-review.icrc.org/articles/reports-and-documents-ihl-and-the-challenges-of-contemporary-armed-conflicts-927> (accessed on 15 November 2025).

<sup>25</sup> UNITED NATIONS. *Report of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems (LAWS)*. Available at: <https://docs.un.org/en/CCW/GGE.1/2021/3> (accessed on 15 November 2025).

<sup>26</sup> UNITED NATIONS GENERAL ASSEMBLY. *Charter of the United Nations and Statute of the International Court of Justice*. 1945. Ibid.

<sup>27</sup> STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE (SIPRI). *SIPRI Yearbook 2024: Armaments, Disarmament and International Security*. Stockholm: SIPRI, 2024. Available at: <https://www.sipri.org/yearbook/2024> (accessed on 15 November 2025).

<sup>28</sup> UPPSALA CONFLICT DATA PROGRAM (UCDP). *UCDP Dataset 2024: Armed Conflicts, 1989–2024*. Uppsala: Uppsala University, 2024. Available at: <https://ucdp.uu.se> (accessed on 15 November 2025).

(2) Analytics of norm-setting by international organizations. An important stage of the study was the calculation of the number of resolutions, reports, official documents of the United Nations (UN), ICRC, GGE, which mention the terms "autonomous weapon systems", "AI in warfare". This made it possible to clarify the reaction of the international community to technological development.

(3) Analysis of IHL violations using new technologies. For this purpose, several conflict situations were selected (Libya, Syria, Ukraine, Nagorno-Karabakh, Gaza Strip). The following variables were coded for each case: Whether autonomous systems were used; Whether cyber operations were carried out. Whether significant civilian casualties occurred; Whether there was an investigation by IHL or international organizations.

Since the principles of international humanitarian law are normative categories, they are not subject to direct quantitative measurement. Therefore, this study operationalizes the relevant principles based on observed indicators of armed conflicts. The quantitative analysis aims to explore the links between technological characteristics of the conflict and indicators potentially relevant for assessing compliance with IHL.

Comparison of IHL principles and variables: The principle of distinction and indicators of civilian casualties and the total number of recorded incidents (IHLv). The principle of proportionality and the lethality index (Deadliness) and IHLv. The duty to take precautions and indicators of danger to the civilian population (Danger) and the presence of investigations. Thus, the empirical part of the study will identify associative dependencies between the use of certain technological categories.

The method of descriptive statistics was used to analyze the data, in particular, time series (2015-2024) were formed for the first component, frequency tables for the second and third components. A correlation method was also used to test the relationship between the frequency of use of autonomous/cyber systems and the number/frequency of IHL violations.

A regression analysis model of the following type was formed. Also added control variables from the ACLED Index (December 2024):

$$IHLviolations_i = \beta_0 + \beta_1 \times AutonomousUsage_i + \beta_2 \times CyberAttacks_i + \beta_3 \times Year_i + \beta_4 \times Deadliness_i + \beta_5 \times Danger_i + \beta_6 \times Fragmentation_i + \varepsilon_i \quad (1)$$

This made it possible to assess whether the use of modern technologies is statistically associated with an increased risk of violations of IHL.

## 2.1. Conceptual framework and typology of technologies

Currently, there are discussions about the use of autonomous and digital military technologies. Scholars identify a mix of the concepts of "artificial intelligence", "autonomy", "unmanned systems" and "cyber operations". Such confusion in the terminology circle can complicate legal assessment and empirical operationalization. Therefore, to ensure analytical clarity, this study is based on a multi-level typology of technologies.<sup>29,30</sup>

For legal analysis, a distinction is proposed between three levels of technological participation in combat decision-making:

1. Algorithmic decision support—these are systems that process large data sets, recognize objects, analyze trajectories and predict risks. The final decision on the use of force remains with the person. In this case, the legal issue is the quality of the information base.

<sup>29</sup> Ibid.

<sup>30</sup> STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE (SIPRI). SIPRI Yearbook 2024: Armaments, Disarmament and International Security. 2024. Ibid.

Relevant norms: the principle of distinction; the duty to verify the target; the duty to take precautions.

2. Autonomy in the implementation of functions. This category defines systems that, once activated, are capable of selecting and engaging targets without further human intervention.<sup>31,32</sup>

Relevant principles: distinction; proportionality; safeguards and accountability.

3. Remotely piloted systems are unmanned aerial vehicles that are under constant human control and are not autonomous in the legal sense.

Legal focus: correct target identification; proportionality and escalation control.

A separate important category is cyber operations that can cause consequences equivalent to kinetic attacks. In the context of IHL, the decisive factor is effect.

Principles: distinction; proportionality; protection of civilian infrastructure; accountability.

At the same time, the main goal for doctrinal research is the attribution of responsibility in conditions of autonomous or semi-autonomous decision-making. IHL traditionally assumes human judgment as the basis for assessing proportionality and preventive measures. The transfer of some functions to algorithmic systems makes it difficult to establish: the subject of the violation; the level of culpability; the foreseeability of the consequences.

Taking into account the above typology, the authors of the study formed a limited number of testable provisions:

Increasing autonomy increases the risk of violating the principles of distinction and proportionality.

The use of cyber operations is associated with an increased risk of violations related to the protection of civilian infrastructure.

The increase in the intensity of the use of new technologies correlates with an increase in the number of recorded incidents.

These provisions serve as an analytical framework for empirical testing of associative relationships.

### **3. Results and discussion**

#### **3.1. Results**

The rules of international humanitarian law operate based on the Geneva Conventions adopted in 1949 (entered into force in 1950).<sup>33</sup> Additional protocols were also ratified, which set out the fundamental principles establishing legal norms, legal distinctions between combatants and civilians, proportions in the use of force, and the prohibition of the use of indiscriminate weapons.<sup>34</sup> However, the current use of autonomous combat systems, unmanned drones and mechanized systems, and special cyber operations raise questions about the extent to which such rules and regulations are in line with the current realities of international humanitarian

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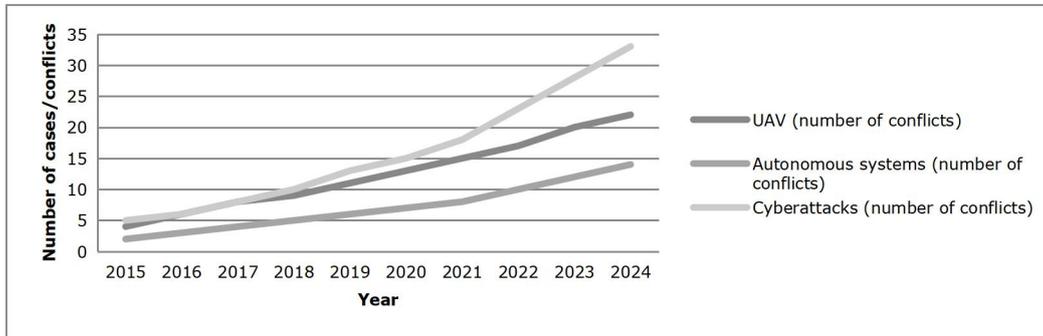
<sup>31</sup> PERIŠIĆ, P.; TOMLJENOVIĆ, M. Legal Permissibility of Autonomous Weapon Systems, with Specific Reference to the Principles of International Humanitarian Law. *Zbornik radova Pravnog fakulteta u Splitu*, 2024, vol. 61, no. 4, pp. 531–555. <https://doi.org/10.31141/zrpfs.2024.61.154.531>

<sup>32</sup> PASHA, A. M.; ABDURAKHMAN OGLU, A. B.; KHALILOV, F. Y.; ZAKIR KIZI, H. I. The use of electronic evidence in court: a comparative legal analysis in the world practice. *Cuestiones Políticas*, 2022, vol. 40, no. 72, pp. 385–394. <https://doi.org/10.46398/cuestpol.4072.21>

<sup>33</sup> CONVENTION (IV) RELATIVE TO THE PROTECTION OF CIVILIAN PERSONS IN TIME OF WAR. Geneva, 12 August 1949. Ibid.

<sup>34</sup> ADDITIONAL PROTOCOL I to the Geneva Conventions of 12 August 1949. Protocol I relating to the Protection of Victims of International Armed Conflicts. 1977. Ibid.

law.<sup>35,36</sup> Therefore, the lack of precise criteria for determining the level of autonomy of weapons and their compliance with the principles of IHL creates legal gaps that need to be addressed. This leads to an increase in the use of ACS on the battlefield and raises concerns about their impact on the principles of IHL (See Figure 1).<sup>37,38</sup>



**Figure 1.** Dynamics of the use of technology in armed conflicts (2015–2024). Source: based on Uppsala Conflict Data Program (UCDP) and reports from the Stockholm International Peace Research Institute (SIPRI).<sup>39,40</sup>

Figure 1 showed an increase in the frequency of use of each technology, with the line reflecting cyberattacks having the steepest slope, and the coefficient of determination of the trend ( $R^2$ ) exceeding 0.9. That is, this indicated the stability of the trend. Since 2020, there has been a clear transition from the stage of experimental use to the mass use of dual-use technologies. The war in Ukraine (2022–2024) has become one of the most noticeable examples of the integration of drones, autonomous systems and cyber operations within one theater of military operations. In this country, the number of drone applications exceeded 8,500 episodes in 2024 and cyberattacks reached over 2,300 incidents. An increase in technological activity was also observed in the Israel–Gaza conflict. This is especially noticeable in 2023, when the Israeli Defense Forces actively used drones for pinpoint strikes and reconnaissance, and cyber operations became a component of the information confrontation. In Syria and Libya, the level of technological involvement remained moderate, although the use of drones was recorded consistently throughout the years.

<sup>35</sup> TILT, D. International Perspectives on Regulatory Frameworks: AI Through the Lens of Patent Law. In: *Artificial Intelligence and Normative Challenges*. Cham: Springer International Publishing, 2023, pp. 171–190. [https://doi.org/10.1007/978-3-031-41081-9\\_10](https://doi.org/10.1007/978-3-031-41081-9_10)

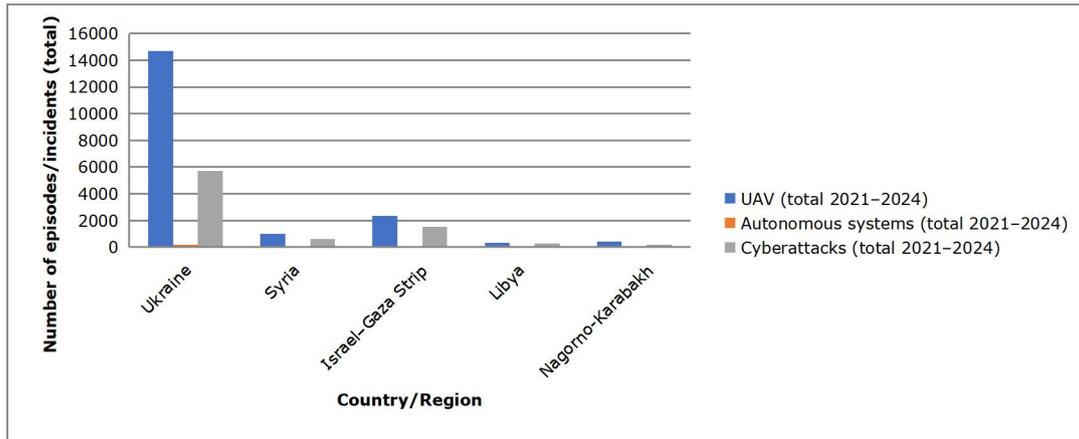
<sup>36</sup> BONDARENKO, Svitlana et al. Planning, Accounting and Control as Risk Management Tools for Small Business Investment Projects. *Emerging Science Journal*, vol. 5, no. 5, p. 650–666, 1 Oct. 2021. <https://doi.org/10.28991/esj-2021-01302>

<sup>37</sup> PERIŠIĆ, P.; TOMLJENOVIĆ, M. Legal Permissibility of Autonomous Weapon Systems, with Specific Reference to the Principles of International Humanitarian Law. 2024. Ibid.

<sup>38</sup> PASHA, A. M.; ABDURAKHMAN OGLU, A. B.; KHALILOV, F. Y.; ZAKIR KIZI, H. I. The use of electronic evidence in court: a comparative legal analysis in the world practice. 2022. Ibid.

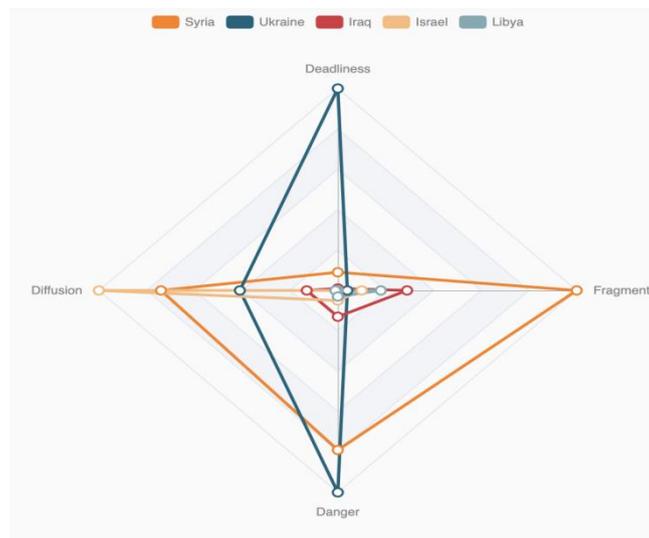
<sup>39</sup> STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE (SIPRI). *SIPRI Yearbook 2024: Armaments, Disarmament and International Security*. 2024. Ibid.

<sup>40</sup> UPPSALA CONFLICT DATA PROGRAM (UCDP). *UCDP Dataset 2024: Armed Conflicts, 1989–2024*. 2024. Ibid.



**Figure 2.** Summary graph: intensity of technology use (amounts for 2021–2024). Source: based on Uppsala Conflict Data Program (UCDP) and reports from the Stockholm International Peace Research Institute (SIPRI).

Ukraine showed the highest indicators for Deadliness and Danger. This indicated high lethality and threat to the civilian population. Syria is characterized by significant fragmentation of the conflict: multiplicity of actors and complexity of monitoring the implementation of IHL norms. Iraq and Libya have average values, and Israel has lower Deadliness levels, but increased Diffusion. This determined the technological nature of escalations and point but intense strikes. Figure 1 shows a comparative radar chart of five conflicts: Ukraine, Syria, Iraq, Israel, and Libya by the main components of the ACLED index.



**Figure 3.** Radar chart of conflict lethality and humanitarian risk indicators. Source: ACLED Conflict Index Dashboard<sup>41</sup>.

The relationship between the level of technology use and the number of violations of international humanitarian law was established based on Pearson correlation analysis. The following variables were considered: the intensity of the use of autonomous systems, cyberattacks, the total number of recorded violations of IHL, the year of observation, and indicators from the ACLED index.

<sup>41</sup> ACLED (Armed Conflict Location & Event Data Project). ACLED Conflict Index Dashboard: Global Overview, December 2024. Washington, D.C.: ACLED, 2024. Available at: <https://acleddata.com/platform/conflict-index-dashboard> (accessed on 15 November 2025).

**Table 1.** Correlation matrix between the main variables (2015–2024).

Indicators	AU	CA	IHLv	DL	DG	F	Year
Autonomous Usage	1.00	0.71	0.65	0.54	0.41	0.32	0.39
Cyber Attacks	0.71	1.00	0.80	0.63	0.58	0.27	0.47
IHL violations	0.65	0.80	1.00	0.71	0.65	0.43	0.41
Deadliness	0.54	0.63	0.71	1.00	0.62	0.36	0.38
Danger	0.41	0.58	0.65	0.62	1.00	0.44	0.35
Fragmentation	0.32	0.27	0.43	0.36	0.44	1.00	0.29
Year	0.39	0.47	0.41	0.38	0.35	0.29	1.00

Source: Author’s calculation. Note: IHLV – number of violations of international humanitarian law (IHL Violations), AU – level of use of autonomous systems, CA – frequency of cyberattacks, DL – conflict lethality indicator, DG – level of danger to the civilian population, FR – degree of conflict fragmentation (Fragmentation).

The highest correlation is noticeable between the variables CyberAttacks Count and IHLviolations Count ( $r = 0.80$ ). Thus, there is a noticeable strong correlation between the frequency of cyber operations and the number of recorded incidents related to international humanitarian law.

This means that the increase in the number of cyberattacks is associated with an increase in the number of documented cases of violations of humanitarian norms. At the same time, the relationship between indicators such as Deadliness Value and IHLviolations ( $r = 0.71$ ) is also noticeable. This indicated that in countries with more lethal conflicts (high human losses) violations of international humanitarian law are more often recorded. To quantitatively confirm the identified relationships, a multiple linear regression model was formed. The obtained value of  $R^2 = 0.91$  indicated that the model has high explanatory power—91% of the fluctuations in the number of IHL violations are due to variations in the use of autonomous systems, the frequency of cyberattacks, and the time factor.

The obtained statistical relationships should be interpreted taking into account the operationalization of the principles of international humanitarian law, which are reflected in the methodological section. In particular, the IHLv variable is defined as a generalized indicator of reported incidents potentially relevant to the principle of distinction. The Deadliness indicator is used as a quantitative characteristic of the lethality of the conflict. This indicator is important for assessing proportionality. The Danger index is associated with risks to the civilian population and indicates practical aspects of preventive measures.

**Table 2.** Regression model of the dependence of IHL violations on technological characteristics of the conflict.

Parameter	Estimate $\beta$	p-value	Interpretation
Const	-5 879.14	0.003	Constant component of the model
Autonomous Usage Index	15.34	0.018	Each unit of autonomy increases IHL violations by $\approx 15$
Cyber Attacks Count	0.19	0.000	Each cyberattack is associated with $\approx 0.19$ IHL violations
Year	2.41	0.061	Slight increase in violations over time
Deadliness Value	0.011	0.008	Higher lethality $\rightarrow$ more IHL violations
Danger Value	0.054	0.072	Higher risk to civilians $\rightarrow$ more violations are recorded
Fragmentation Value	0.013	0.042	Fragmented conflicts $\rightarrow$ higher probability of violations
$R^2 = 0.91$			91% of the variation is explained by the model

These results showed that the growth of the technological component of armed conflicts directly affects the escalation of violations of IHL, and the current

regulatory framework does not provide adequate deterrent mechanisms. From a legal point of view, the use of modern technologies is a rather urgent challenge for international humanitarian law. Important aspects include the development of specific international forms of control that will require adaptation and development. The current Geneva Conventions do not legally regulate those provisions that explicitly define the use of modern digital autonomous systems.<sup>42,43,44</sup> For this reason, there is an immediate need to define the level of autonomy that allows us to clearly determine whether the responsibility of a human operator remains. In 2017, Amnesty International called on the UN to amend the international law system and ban fully autonomous weapons systems, at least because modern military developments are ahead of humanitarian law.<sup>45</sup> The use of autonomous weapons capabilities would create a conflict with opposition from national and international law enforcement systems. Moreover, the issue of the legitimacy of cyberattacks is extremely relevant. The experience of Russian attacks on Ukrainian critical infrastructure shows that the attackers targeted not only military facilities, but also civilian structures that ensure the vital functions of public life. Therefore, the issue of the low selectivity of the consequences of cyberattacks creates a legal dilemma, the essence of which is the extent to which such attacks are equivalent to armed attacks.

### 3.2. Discussion

The dynamics of the use of technology in conflicts and wars in 2015–2024 showed a trend towards an increase in the technological saturation of military operations. The indicators of the use of unmanned aerial vehicles (UAVs), autonomous systems and cyberattacks demonstrated a steady growth after 2019, with a sharp peak in 2022–2023, a period of escalation of high-tech conflicts, in Ukraine, Syria and the Gaza Strip. These trends indicated that modern warfare is gradually transitioning from “contact” to digital-algorithmic. Such data is also confirmed in other works, where it is indicated that the use of autonomous drones, guided fire systems and artificial intelligence in target recognition has changed the nature of military management.<sup>46,47,48</sup>

<sup>42</sup> YUCEL, A.; JAN, J.; ASLAM, M. Z.; AZIZ, M. A. Drones, Bots, and the Law: Charting the Terrain of Autonomous Weapon Systems in International Conflict. *Society, Law and Policy Review*, 2023, vol. 2, no. 1, pp. 26–36. <https://doi.org/10.62585/slpr.v2i1.27>

<sup>43</sup> UGWU, O. P.-C.; ALUM, E. U.; UGWU, J. N.; EZE, V. H. U.; UGWU, C. N.; OGENYI, F. C.; OKON, M. B. Harnessing technology for infectious disease response in conflict zones: Challenges, innovations, and policy implications. *Medicine*, 2024, vol. 103, no. 28, article e38834. <https://doi.org/10.1097/md.00000000000038834>

<sup>44</sup> WANG, N.; CHRISTEN, M.; HUNT, M.; BILLER-ANDORNO, N. Supporting value sensitivity in the humanitarian use of drones through an ethics assessment framework. *International Review of the Red Cross*, 2022, vol. 104, no. 919, pp. 1397–1428. <https://doi.org/10.1017/s1816383121000989>

<sup>45</sup> AMNESTY INTERNATIONAL. Annual report 2022/23: The state of the world’s human rights. London: Amnesty International, 2023. Available at: <https://www.amnesty.org/en/documents/pol10/5670/2023/en/> (accessed on 15 November 2025).

<sup>46</sup> KOZLOVSKYI, S.; MAZUR, H. Ensuring the stability of the modern economic system – the basis of the economic development of the state. *Investytsii: praktyka ta dosvid – Investments: Practice and Experience*, 2017, no. 1, pp. 5–12. Available at: <http://www.investplan.com.ua/?op=1&z=5316&i=0> (accessed on 15 November 2025).

<sup>47</sup> KRAP, A.; BATAIEV, S.; BOBRO, N.; KOZUB, V.; HLEVATSKA, N. Examination of digital advancements: Their influence on contemporary corporate management methods and approaches. *Multidisciplinary Reviews*, 2024, vol. 7, article 2024spe026. <https://doi.org/10.31893/multirev.2024spe026>

The results of the quantitative analysis determined a high degree of correlation between the intensity of technological application and the number of recorded violations of international humanitarian law. The strongest correlation was found between cyberattacks ( $r = 0.80$ ) and violations of IHL. Thus, cyberwarfare affects the humanitarian situation. Data from the ACLED (Deadline, Danger, Fragmentation) index showed that in countries with high levels of lethality and danger (Ukraine, Syria, Sudan), the technological component of war is directly associated with an increase in the scale of humanitarian incidents. Such data can be compared with other works that indicate that technology complements traditional means of warfare.<sup>49,50</sup> Cyberaggression against civilian infrastructure is of particular concern.

The comparison of empirical results with legal provisions has shown a growing gap between technological reality and the current regulatory framework. The 1949 Geneva Conventions and the 1977 Additional Protocols remain the basis of IHL, but their wording does not envisage the use of autonomous algorithms or cyberattacks as a form of armed action. Existing UN, ICRC and Group of Governmental Experts (GGE) documents are mainly advisory in nature. This in turn does not create binding norms for aggressor states. Moreover, when analyzing existing international law, it is also important to consider ethical challenges that are important for law enforcement. Certain dilemmas are related to both the application of legal responsibility and broader issues of morality and their combination with digital and automated warfare systems.<sup>51,52</sup> In fact, the norms of modern international humanitarian law are based on the principles of humanism, even during military operations.<sup>53,54</sup> Therefore, the use of technology may lead to certain situations that do not require emotional or ethical analysis but are based on the outright use of force. Discussion of the possibilities of resolving existing and potential legal conflicts regarding the punishment and establishment of liability for the misuse of automated systems. Among the difficulties in applying modern legal norms on

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<sup>48</sup> MACCARO, A.; STOKES, K.; STATHAM, L.; HE, L.; WILLIAMS, A.; PECCHIA, L.; PIAGGIO, D. Clearing the Fog: A Scoping Literature Review on the Ethical Issues Surrounding Artificial Intelligence-Based Medical Devices. *Journal of Personalized Medicine*, 2024, vol. 14, no. 5, article 443. <https://doi.org/10.3390/jpm14050443>

<sup>49</sup> DERVIŞ, Leyla. Transformation of Geopolitical Perceptions in the Russian-Ukrainian War: Impact on Regional Relations in the Future. *Futurity of Social Science*, 2023, vol. 1, no. 1, pp. 21-34. Available at: <https://doi.org/10.57125/FS.2023.03.20.02>

<sup>50</sup> GRYSHCENKO, I. M.; DENYSOVA, A. V.; OVSIANNIKOVA, O. O.; BUHA, H. S.; KISELYOVA, E. I. Means for control over the activities of public authorities by civic democratic institutions: the conceptual framework analysis. *Cuestiones Políticas*, 2021, vol. 39, no. 69, pp. 796-813. <https://doi.org/10.46398/cuestpol.3969.49>

<sup>51</sup> XIAOLING, P. Discussion on ethical dilemma caused by artificial intelligence and countermeasures. In: 2021 IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC). IEEE, 2021, pp. 453-457. <https://doi.org/10.1109/IPEC51340.2021.9421271>

<sup>52</sup> BONDAR, I. et al. State regulation of the development of educational and scientific process in higher education institutions. *Journal of management Information and Decision Sciences*, vol. 24, no. 2, p. 1-10, 2021. Available at: <https://www.abacademies.org/articles/state-regulation-of-the-development-of-educational-and-scientific-process-in-higher-education-institutions-10158.html> (accessed on 15 November 2025).

<sup>53</sup> PASHA, A. M. Criminal Procedure and Forensic Aspects of Mutual Legal Assistance between States in Criminal Matters: Experience of Ukraine and the Republic of Azerbaijan. *Cuestiones Políticas*, 2022, vol. 40, no. 72, pp. 591-607. <https://doi.org/10.46398/cuestpol.4072.35>

<sup>54</sup> HALYTSKA-DIDUKH, T.; SALATA, S.; NASHYVOCHNIKOV, O.; DERVIŞ, L.; SOLOVEI, H. Emergence of Modern Historical Policy in the Russian-Ukrainian War Context: Assessing Transformations in Global Order Paradigms and Present Challenges. *Amazonia Investiga*, 2023, vol. 12, no. 68, pp. 141-150. Available at: <https://dialnet.unirioja.es/descarga/articulo/9385609.pdf> (accessed on 15 November 2025).

automated warfare systems (including the moral and ethical aspects), the authors identify the lack of clear criteria for the use of autonomous weapons, the lack of methods to counter cyber operations in military conflicts, and problems with determining the legal status of artificial intelligence for military use.<sup>55</sup> A similar issue of legal responsibility in the context of autonomous and semi-autonomous systems is raised by I. Vuletić, who draws attention to the limitations of the traditional concept of command responsibility in situations where decisions on the use of force are made with the involvement of algorithmic systems. The author substantiates the existence of legal gaps in international criminal law and emphasizes the problem of unconscious negligence as a potential basis for liability for crimes committed with the use of autonomous weapons.<sup>56</sup>

The empirical results do not directly change the content of international humanitarian law, but they do reveal areas of heightened normative tension when applied to modern technologies. In particular, the growing role of autonomous systems and cyber operations complicates the practical implementation of the principle of distinction between civilians and combatants, the assessment of proportionality of harm, and the obligation to take precautions during an attack. Thus, the quantitative data serves as a basis for a critical rethinking of the practice of applying existing IHL norms in new technological conditions.

First, the researchers note several approaches to further solutions to such legal issues. On the one hand, the possibility of amending and supplementing existing international conventions and treaties, including those that define international standards for responding to threats to humanitarian law, seems productive<sup>57</sup>. According to Article 8 of the Chicago Convention, a UAV is defined as a specific aircraft without a pilot on board.<sup>58,59</sup> The aircraft flies in a predetermined direction when there is no pilot on board. Such an object can fly independently according to a predetermined program or being controlled remotely. Certain recommendations for the use of UAVs are set out in the 1944 Convention on International Civil Aviation, also known as the Chicago Convention.

According to Article 8, no unmanned aerial vehicle may fly over the territory of another state without the consent of that state. To ensure the safety of civil aviation, it also provides for the use of UAVs in air corridors. Standards and recommendations for pilot licensing, aircraft operation and airworthiness are contained in the annexes to the Convention. It was noted that as UAVs are aircraft, they are subject to the same basic laws and regulations as conventional aviation. Some amendments were made to the annexes of the Chicago Convention, requiring that UAVs be certified for safety, operated by a qualified operator and piloted by a licensed pilot. Such initiatives are comparable to calls for some reform of existing international instruments<sup>60,61,62,63</sup>. In the end, this position of legal scholars seems

<sup>55</sup> AMNESTY INTERNATIONAL. Annual report 2022/23: The state of the world's human rights. 2023. Ibid.

<sup>56</sup> VULETIĆ, Igor. Rethinking command responsibility in the context of emerging AI weapons. EU and comparative law issues and challenges series (ECLIC), 2023, vol. 7, pp. 163-80. <https://doi.org/10.25234/ecllc/28262>

<sup>57</sup> BILLER, J.; GOINES, T. Protecting Civilian Data in Armed Conflicts. 2023. Ibid.

<sup>58</sup> CONVENTION ON INTERNATIONAL CIVIL AVIATION. Montreal: International Civil Aviation Organization (ICAO, Doc. 3700), 2000. Retrieved 11 March 2026. Available at: [https://www.icao.int/sites/default/files/2024-12/7300\\_8ed.pdf](https://www.icao.int/sites/default/files/2024-12/7300_8ed.pdf) (accessed on 15 November 2025).

<sup>59</sup> UNITED NATIONS OFFICE FOR DISARMAMENT AFFAIRS (UNODA). Promoting Responsible Innovation in Artificial Intelligence for Peace and Security. Available at: <https://disarmament.unoda.org/en/responsible-innovation-ai/about> (accessed on 15 November 2025).

<sup>60</sup> TLYCHYK, O.; DRAGAN, O.; NAZYMKO, O. Establishing the Ratio of Concepts of Counteraction to Legalization (Laundering) of Illegally-Obtained Income and Counteraction to

to be extremely productive, as it proposes only certain changes to existing documents. In our opinion, the international community should not only update the provisions of existing treaties (in particular, the Geneva Conventions and Additional Protocols) but also begin to develop a new universal international convention that would comprehensively regulate the legal status, responsibility and limits of the use of autonomous military technologies. Such a convention should contain clear definitions of concepts (for example, "military-purpose artificial intelligence", "autonomous weapons", "human control"), procedural guarantees to prevent abuse, as well as mechanisms for the responsibility of both states and system manufacturers/operators. Only such an approach will ensure the right balance between innovation and legal control in the field of armed conflict. Despite the data obtained, the study has certain limitations. Information on the use of autonomous systems, cyberattacks and artificial intelligence in conflicts was based on open reports from SIPRI, UCDP, ACLED and reports from international organizations. Some of the data is incomplete due to the secrecy of military operations and differences in the methods of recording events.

The results obtained should be interpreted as statistical associations, and not as cause-and-effect effects. In particular, the identified connections may be due to a number of extraneous factors, for example, and indicators of conflict intensity, military capabilities of the parties, the level of technological equipment, etc.

Thus, the dependencies indicated in the study reflect the structural patterns of covariation of indicators, but do not allow conclusions to be drawn about the direct causal impact of the use of technologies.

The correlation and regression analysis used in the study has limited explanatory power. The results show statistical relationships between the intensity of technology use and the number of recorded violations of international humanitarian law, but do not establish direct cause-and-effect relationships. The quantitative indicators serve as indicators of structural trends that require further legal and doctrinal understanding, rather than as independent evidence of causality.

#### 4. Conclusions

The analysis showed an increase in the level of technologicalization of armed conflicts in 2015–2024, the intensive use of autonomous systems, unmanned platforms and cyber operations. After 2020, a transition from experimental to systematic use of these technologies can be traced, which was especially clearly manifested in some modern conflicts.

The results of the quantitative analysis confirmed the presence of a statistically significant relationship between the intensity of the use of technological means and the number of recorded violations of international humanitarian law. The highest correlation was observed between the frequency of cyber operations and violations of IHL. The regression model indicated a high explanatory power of technological variables, which determined much of the variation in the number of violations.

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the Shadow Economy. *Baltic Journal of Economic Studies*, 2018, vol. 4, no. 4, pp. 341–346. Available at: <http://www.baltijapublishing.lv/index.php/issue/article/view/518/pdf> (accessed on 15 November 2025).

<sup>61</sup> KOZLOVSKYI, S.; KULINICH, T.; MAZUR, H.; KHADZHYNOV, I.; KOZLOVSKYI, V. Forecasting the competitiveness of the agrarian sector of Ukraine in the conditions of war and European integration. *Bulgarian Journal of Agricultural Science*, 2023, vol. 29, no. 5, pp. 774–783.

<sup>62</sup> TSILONIS, V. Lethal Autonomous Weapons, Drones and Robots: To What Extent Their Usage Infringes Upon Established Principles of International Criminal Law? 2024. *Ibid.*

<sup>63</sup> SYSOIEV, D.; PIDBEREZNYKH, I.; MAZUR, H.; TELLIS, S.; VANDIN, Y. Administrative law mechanisms for preventing and countering corruption in the field of territorial defence. *Sapienza*, 2024, vol. 5, no. 4, e24069. <https://doi.org/10.51798/sijis.v5i4.859>

Furthermore, the results indicated a normative tension between the current provisions of IHL and modern technological developments in armed conflicts.

Proposals to adapt existing international legal treaties or to develop a new universal instrument are based on the established practice of progressive codification of international humanitarian law. The historical development of the Geneva Conventions and Additional Protocols shows that the emergence of new means and methods of warfare has traditionally necessitated the revision or amendment of treaty norms in order to preserve humanitarian principles.

Thus, the data presented in the article reveal a normative tension between the current provisions of IHL and the observed technological changes in contemporary conflicts. At the same time, these conclusions are based on statistical association analysis and do not establish a causal link between the use of autonomous weapons and violations of international humanitarian law.

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