

Research Papers

A Wartime Sexual Violence Against Women in Modern Conflict: Legal Challenges and Responses in Bangladesh (1971) and the Rohingya Crisis

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From the Chief Editor

It is my privilege to present the June 2025 edition of *Pragyaan: Journal of Law*, dedicated to the theme *Modern Warfare and the Law*. This issue explores the evolving nature of armed conflict—where cyber operations, autonomous weapon systems, hybrid strategies, and emerging technologies challenge established legal frameworks and humanitarian principles.

The contributions in this volume address diverse yet interconnected areas, including the regulation of maritime autonomous vessels under the laws of war, wartime sexual violence and its legal responses, cyberattacks against critical sectors such as healthcare, the implications of cyber and information warfare for national and global security, the economic dimensions of conflict, and the intersection of biotechnology and artificial intelligence with contemporary legal challenges. Alongside these, the issue also features analyses of India's green energy policies, the evolution from corporate to sustainable governance, and other emerging questions in public and private law.

Together, these works provide valuable insight into how law must adapt to shifting realities, offering pathways for reform and greater accountability. I extend my gratitude to our authors, reviewers, and editorial team for their commitment to advancing this crucial discourse.

Warm regards,

Prof (Dr) Amit Adlakha

Chief Editor

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CONTENTS

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- | | | |
|-----|---|-------|
| 1. | A Wartime Sexual Violence Against Women in Modern Conflict: Legal Challenges and Responses in Bangladesh (1971) and the Rohingya Crisis
Dr. Neha Damani | 1-5 |
| 2. | The Evolving Landscape of Cyber and Information Warfare: Implications for National Security and Global Stability
Dr. Tanveer Kaur | 6-12 |
| 3. | The Invisible Battlefield: How Tariffs Replace Troops in 21st-Century Conflicts
Khushbu Maheshwari, Vardhman Jain | 13-23 |
| 4. | Cyber Attacks against the Healthcare Sector and the Use of Force under International Law
Ms. Jyoti Singh | 24-30 |
| 5. | "Corporate Governance to Sustainable Governance: Fifty Years Journey of Indian laws"
Harshika Kapoor, Maneesh Yadav | 31-39 |
| 6. | Biotechnology and Artificial Intelligence: Emerging Legal Issues
Dr. Pratibha Rathod | 40-46 |
| 7. | Green Energy Policies in India: A Critical Analysis of Legal Frameworks
Rita Pandey, Himanshu Muniyal | 47-58 |
| 8. | Critical Study on Maritime Autonomous Vessels and their compliance with International War Laws
I.P. Mithu | 59-65 |
| 9. | Between Law and War: A Critical study on Human Rights Violations and the Role of International Legal Mechanisms
Sri Soumya Mulagaleti, Dharineesh Rajagopal | 66-75 |
| 10. | "From Battlefields to Seabed: The Environmental Toll of Warfare on Terrestrial and Submarine Ecosystems"
Vishakha Singh Parihar | 76-84 |

A Wartime Sexual Violence Against Women in Modern Conflict: Legal Challenges and Responses in Bangladesh (1971) and the Rohingya Crisis

Dr. Neha Damani*

ABSTRACT

Wartime sexual violence remains a pervasive and devastating feature of modern conflicts, disproportionately targeting women. This article examines two case studies - the mass sexual violence during the 1971 Bangladesh Liberation War and the atrocities committed against Rohingya women in recent years - to analyze how evolving international legal frameworks address (or fail to address) such crimes. Despite the development of robust human rights and humanitarian laws, such as the Geneva Conventions, the Rome Statute of the International Criminal Court, CEDAW, and the Women, Peace and Security agenda, significant gaps in enforcement and accountability persist. This paper critically evaluates legal and institutional shortcomings-such as inadequate prosecution, sociocultural stigma, and lack of survivor-centric approaches. Finally, it explores survivor-centered justice initiatives and legal reforms that could bridge the gap between legal commitments and lived realities of survivors.

Keywords: Wartime Sexual Violence, Rohingya, Transitional Justice, CEDAW, Rome Statute, ICT-BD, Bangladesh

I. Introduction

Wartime sexual violence is one of the most widespread, yet under-prosecuted, forms of human rights violations. Historically used not merely as opportunistic crimes but as deliberate strategies of warfare, rape and sexual abuse are employed to terrorize, subjugate, and destroy communities. From the atrocities during the 1971 Bangladesh Liberation War to the recent persecution of Rohingya women by the Myanmar military, patterns of gendered violence are alarmingly similar and persistently under-addressed.

Despite advancements in international humanitarian and criminal law, justice remains elusive for most survivors. Legal tools such as the Rome Statute of the International Criminal Court¹ and the *Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW)² lay down clear standards, yet implementation is frequently thwarted by political compromise, jurisdictional gaps, and systemic stigma. These failures highlight the tension between law in principle and law in action, particularly in regions like South Asia where state accountability mechanisms are often weak or politically constrained.

The present paper builds on these global developments

and examines how wartime sexual violence is addressed (or not) in two key case studies: Bangladesh (1971) and the Rohingya refugee crisis. Both incidents reveal the severe consequences of enforcement failures and the long-term trauma inflicted upon survivors. Furthermore, the paper proposes a survivor-centered justice approach rooted in international law but adapted to domestic realities.

II. The 1971 Liberation War: Historical Atrocity and Legal Response

The Bangladesh Liberation War of 1971 witnessed one of the most systematic uses of sexual violence in modern history. During the nine-month conflict between West Pakistan (now Pakistan) and the people of East Pakistan (now Bangladesh), the Pakistani military and its local collaborators committed widespread atrocities, including rape, torture, and sexual slavery targeting Bengali women. Estimates suggest that between 200,000 and 400,000 women were subjected to sexual violence during the conflict³.

Survivors were later conferred the title of Birangona (meaning "war heroine") by the Bangladeshi government in a symbolic effort to honor their suffering⁴. However, societal stigma persisted. Many victims were ostracized,

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¹. Rome Statute of the International Criminal Court (adopted 17 July 1998, entered into force 1 July 2002) 2187 UNTS 90, arts 7(1)(g), 8

². CEDAW Committee, 'General Recommendation No. 30 on Women in Conflict Prevention, Conflict and Post-Conflict Situations' (1 November 2013) UN Doc CEDAW/C/GC/30

³. Yasmin Saikia, *Women, War, and the Making of Bangladesh: Remembering 1971* (Duke University Press 2011) 15.

⁴. Nayanika Mookherjee, *The Spectral Wound: Sexual Violence, Public Memories and the Bangladesh War of 1971* (Zubaan 2015) 6.

denied marriage prospects, or driven into poverty and social invisibility⁵. The trauma was exacerbated by the state's limited ability to deliver justice or long-term support.

In 1973, the International Crimes (Tribunals) Act was enacted by the newly formed Bangladeshi government to prosecute perpetrators of war crimes, including rape⁶. This legal framework had the potential to set a precedent in addressing sexual violence in conflict. However, political instability and a lack of resources stalled most prosecutions. In 1974, under a tripartite agreement between Bangladesh, India, and Pakistan, 195 Pakistani officers who were allegedly responsible for war crimes—including mass rape—were repatriated without trial in exchange for diplomatic normalization⁷.

Consequently, most rape survivors were denied judicial redress, and the state failed to uphold its own legislative commitment to prosecute war crimes. While Bangladesh revived its tribunal process in 2010, through the establishment of the International Crimes Tribunal of Bangladesh (ICT-BD), justice remained delayed. The ICT-BD did convict several local collaborators and included rape as a crime against humanity in some judgments⁸. However, critics have noted that sexual violence was often prosecuted as a secondary offense, and no comprehensive reparation or psychological support framework was embedded in the process⁹.

Furthermore, many survivors did not testify, either due to fear of stigma or lack of support mechanisms. The limited participation of victims and the absence of formal state apologies or reparations highlight the incomplete nature of transitional justice in this context¹⁰.

III. The Rohingya Crisis: Modern Warfare and Ethnic Violence

The systematic sexual violence committed against the Rohingya Muslim minority in Myanmar, particularly in 2017, marked one of the gravest humanitarian crises of the 21st century. The Myanmar military (Tatmadaw), under the guise of counter-insurgency operations in Rakhine

State, carried out a campaign of mass killings, gang rapes, and village burnings, forcing over 740,000 Rohingya—mostly women and children—to flee into refugee camps in Cox's Bazar, Bangladesh¹¹.

Investigations by the United Nations Fact-Finding Mission (FFM) confirmed that rape and sexual slavery were systematically employed by the Myanmar military to terrorize and ethnically cleanse the Rohingya community¹². Women reported being raped in front of their families, often followed by mutilation or murder. The patterns of violence and the military's planning behind these attacks led the UN to conclude that acts of genocide may have been committed, with sexual violence used as a tool of extermination¹³.

However, Myanmar is not a State Party to the Rome Statute, limiting the jurisdiction of the International Criminal Court (ICC) over crimes committed within its territory. In 2019, the ICC Pre-Trial Chamber ruled that since the deportation of Rohingya into Bangladesh (a State Party) constituted part of the crime, the Court had limited jurisdiction to investigate crimes including rape and sexual violence committed in Myanmar, provided they were linked to forced displacement into Bangladesh¹⁴.

Inside the refugee camps, Rohingya women continued to face insecurity. Trafficking, forced marriage, and sexual exploitation remain ongoing threats¹⁵. The absence of formal refugee status—since Bangladesh is not a signatory to the 1951 Refugee Convention—deprives Rohingya women of legal protections and access to justice¹⁶.

Despite the findings of international bodies and the ICC's ongoing investigation, no high-ranking Myanmar military official has been prosecuted to date. Survivors remain in limbo—stateless, traumatized, and largely ignored by the justice system, both domestically and internationally. The failure to deliver swift and visible justice has fuelled perceptions of impunity and may contribute to the recurrence of such crimes in other conflict zones.

⁵ Ibid 9.

⁶ International Crimes (Tribunals) Act 1973 (Bangladesh), as amended by Act No. XIX of 2009.

⁷ Agreement between Bangladesh, India and Pakistan (Tripartite Agreement), New Delhi (9 April 1974) https://legal.un.org/avl/pdf/ha/gtici/gtici_ph_e.pdf accessed 13 April 2025.

⁸ David Bergman, 'Bangladesh War Crimes Trials: All You Need to Know' (Al Jazeera, 9 December 2014) <https://www.aljazeera.com/features/2014/12/9/bangladesh-war-crimes-trials-all-you-need-to-know> accessed 13 April 2025.

⁹ Ibid.

¹⁰ Mookherjee (n 4) 13.

¹¹ UN Human Rights Council, 'Report of the Independent International Fact-Finding Mission on Myanmar' (12 September 2018) UN Doc A/HRC/39/64 <https://www.ohchr.org/en/documents/country-reports/report-independent-international-fact-finding-mission-myanmar-a/hrc3964> accessed 13 April 2025.

¹² Ibid

¹³ Ibid 15.

¹⁴ Prosecutor v Myanmar, Decision on the "Prosecution's Request for a Ruling on Jurisdiction under Article 19(3) of the Statute" (Pre-Trial Chamber I, ICC, 6 September 2018) ICC-RoC46(3)-01/18.

¹⁵ Human Rights Watch, 'Bangladesh: Rohingya Refugees at Risk from Cyclone, Traffickers' (28 May 2023) <https://www.hrw.org/news/2023/05/28/bangladesh-rohingya-refugees-risk-cyclone-traffickers> accessed 3 April 2025

¹⁶ UN General Assembly, Convention Relating to the Status of Refugees (adopted 28 July 1951, entered into force 22 April 1954) 189 UNTS 137.

IV. International Legal Frameworks: Promise vs. Reality

International law today recognizes wartime sexual violence as among the most serious violations of international humanitarian and human rights norms. Over the past few decades, significant progress has been made in codifying rape, sexual slavery, enforced prostitution, and related crimes as war crimes, crimes against humanity, and acts of genocide. However, as illustrated by the Bangladesh and Rohingya case studies, the translation of these norms into justice remains uneven and limited.

A. Geneva Conventions and International Humanitarian Law (IHL)

The 1949 Geneva Conventions prohibit outrages upon personal dignity, which has been interpreted to include rape and sexual abuse. Geneva Convention IV, Article 27, explicitly states that women shall be protected against rape, enforced prostitution, and indecent assault¹⁷. The Additional Protocols of 1977 further reinforced this, especially Protocol I, Article 76, which obligates states to protect women against such abuses during armed conflict¹⁸.

In the Bangladesh Liberation War, the Pakistani military, as a Geneva Convention signatory, was bound by these provisions. Each act of sexual violence committed against Bengali women constituted a grave breach of international law. However, no international tribunal existed at the time to prosecute such offenses. Similarly, the Myanmar military's abuses against the Rohingya, if categorized as part of an armed conflict, fall under Common Article 3 and Additional Protocol II, even though Myanmar has not ratified the Additional Protocols. These protections are considered customary international law, binding on all states irrespective of treaty ratification¹⁹.

B. The Rome Statute and the International Criminal Court (ICC)

The Rome Statute of the ICC, adopted in 1998, marked a watershed moment by codifying rape, sexual slavery, enforced prostitution, forced pregnancy, and enforced sterilization as war crimes and crimes against humanity²⁰. Article 7(1)(g) and Article 8 of the Rome Statute provide

detailed definitions, recognizing the gendered nature of conflict-related crimes and establishing a framework for individual criminal liability.

Although Bangladesh is a State Party to the ICC, Myanmar is not, creating jurisdictional limitations. The ICC has partially overcome this through the cross-border nature of Rohingya deportations into Bangladesh, which enabled an investigation under Article 12(2)(a)²¹. Still, lack of enforcement mechanisms and Myanmar's non-cooperation hinder prosecution. The Rome Statute does not allow trials in absentia, and arrest warrants can only be executed with state cooperation—something Myanmar is unlikely to provide.

C. CEDAW and General Recommendation No. 30

The Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), adopted in 1979, requires states to eliminate discrimination and protect women's rights. While it does not explicitly mention armed conflict, the CEDAW Committee's General Recommendation No. 30 (2013) affirms that CEDAW applies during conflict, post-conflict, and peacekeeping scenarios²². It calls on states to prevent, investigate, and punish gender-based violence in conflict, and to provide reparations.

Bangladesh ratified CEDAW in 1984 but maintains reservations on Articles 2 and 16, which weakens its compliance with key obligations²³. Myanmar ratified CEDAW in 1997 without reservations, but its conduct against Rohingya women constitutes a clear breach of its obligations to protect women from violence and discrimination.

D. UN Security Council Resolutions (UNSCR 1325 and Beyond)

UNSCR 1325, adopted in 2000, emphasized the protection of women and girls in conflict zones and their participation in peace building²⁴. Follow-up resolutions such as 1820 (2008), 1888 (2009), and 2467 (2019) focused specifically on conflict-related sexual violence, urging zero tolerance, no amnesty for perpetrators, and survivor-centered justice²⁵.

¹⁷ Geneva Convention (IV) Relative to the Protection of Civilian Persons in Time of War (adopted 12 August 1949, entered into force 21 October 1950) 75 UNTS 287, art 27.

¹⁸ Protocol Additional to the Geneva Conventions of 12 August 1949 (Protocol I) (adopted 8 June 1977, entered into force 7 December 1978) 1125 UNTS 3, art 76.

¹⁹ Jean-Marie Henckaerts and Louise Doswald-Beck, Customary International Humanitarian Law, vol I (ICRC/Cambridge University Press 2005) Rule 93.

²⁰ Rome Statute of the International Criminal Court (adopted 17 July 1998, entered into force 1 July 2002) 2187 UNTS 90, arts 7(1)(g), 8.

²¹ *ibid* art 12(2)(a).

²² CEDAW Committee, 'General Recommendation No. 30 on Women in Conflict Prevention, Conflict and Post-Conflict Situations' (1 November 2013) UN Doc CEDAW/C/GC/30.

²³ UN Women, 'Reservations to CEDAW: Bangladesh' <https://www.un.org/womenwatch/daw/cedaw/reservations-country.htm> accessed 3 April 2025.

²⁴ UNSC Res 1325 (31 October 2000) UN Doc S/RES/1325.

²⁵ UNSC Res 1820 (19 June 2008) UN Doc S/RES/1820; UNSC Res 1888 (30 September 2009) UN Doc S/RES/1888; UNSC Res 2467 (23 April 2019) UN Doc S/RES/2467.

While Bangladesh supports the Women, Peace, and Security agenda, it has yet to adopt a formal National Action Plan (NAP), which would provide a roadmap to implement these commitments²⁶. Myanmar, despite being under intense international scrutiny, has completely failed to heed these resolutions, illustrating the limits of non-binding instruments in the face of state defiance.

V. Challenges to Implementation and Accountability

Despite the availability of international legal frameworks addressing wartime sexual violence, their practical implementation remains obstructed by a host of challenges. The Bangladesh and Rohingya cases highlight not only the structural deficiencies in legal enforcement but also the deeper social, political, and procedural issues that perpetuate impunity and silence survivors.

A. Jurisdictional Barriers and State Sovereignty

The Rome Statute's jurisdiction is limited to crimes committed on the territory of States Parties or by their nationals. Myanmar's non-membership restricts the ICC's authority unless referred by the UN Security Council, which has been blocked due to China and Russia's geopolitical support for Myanmar²⁷. Similarly, Bangladesh in 1971 lacked access to an international tribunal, as no court like the ICC existed then. These jurisdictional gaps have consistently denied survivors a legal forum to seek justice.

B. Political Will and Realpolitik Compromises

Accountability processes often fall victim to political calculations. In 1974, Bangladesh chose diplomatic normalization with Pakistan over prosecuting 195 Pakistani officers accused of rape and genocide²⁸. Myanmar has similarly refused to cooperate with any investigations, instead maintaining the legitimacy of its military's actions. The absence of political will, both domestically and internationally, contributes significantly to justice being delayed or denied.

C. Evidence Collection and Survivor Testimony

The prosecution of sexual violence requires credible, corroborated evidence, which is often unavailable due to delays, trauma, or lack of forensic infrastructure. In

Bangladesh's ICT-BD trials, survivor testimony was limited, and documentation from 1971 was sparse²⁹. For the Rohingya, evidence collection relies heavily on refugee accounts, often in unstable and insecure environments. The Independent Investigative Mechanism for Myanmar (IIMM) was created to preserve such evidence, but it is not yet linked to a prosecution body³⁰.

D. Social Stigma and Cultural Silence

Stigma around rape continues to deter survivors from coming forward. In Bangladesh, many Birangona were never officially recognized due to societal shame³¹. Rohingya women similarly fear community backlash, especially if they conceived children from rape. This cultural silence undermines both legal processes and social healing, leaving survivors isolated and invisible.

E. Lack of Survivor-Centric Approaches

Most accountability frameworks focus on punishing perpetrators, often neglecting the needs of survivors. The ICT-BD did not offer reparations, trauma counseling, or protection for witnesses³². The ICC has a Trust Fund for Victims, but it has yet to operationalize benefits for Rohingya survivors. Justice processes that fail to prioritize survivor dignity and healing risk reinforcing harm rather than addressing it.

VI. Recommendations for Survivor-Centered Reform

To bridge the persistent gap between legal obligations and survivor realities, a survivor-centered justice model is essential. This approach goes beyond punishing perpetrators and focuses on the dignity, needs, and participation of survivors. Based on the lessons from Bangladesh and the Rohingya crisis, the following legal and policy recommendations aim to transform accountability from symbolic gestures into substantive justice:

A. Adopt a National Action Plan (NAP) on Women, Peace and Security

Bangladesh must adopt a NAP on UNSCR 1325, outlining a comprehensive strategy for preventing gender-based violence, empowering women in peacebuilding, and

²⁶ Saferworld, 'Bangladesh: Civil Society Input on Women, Peace and Security' (2019) <https://www.saferworld.org.uk/resources/publications/1226-bangladesh-civil-society-input-on-women-peace-and-security> accessed 13 April 2025.

²⁷ UN Security Council, 'Report of the Secretary-General on Conflict-Related Sexual Violence' (29 March 2022) UN Doc S/2022/272.

²⁸ Rome Statute of the International Criminal Court (adopted 17 July 1998, entered into force 1 July 2002) 2187 UNTS 90, art 7(1)(g); CEDAW Committee, 'General Recommendation No. 35 on Gender-Based Violence against Women' (14 July 2017) UN Doc CEDAW/C/GC/35.

²⁹ UN Women, 'Handbook for Legislation on Violence Against Women' (2012) <https://www.unwomen.org/en/digital-library/publications/2012/12/handbook-for-legislation-on-violence-against-women> accessed 3 April 2025.

³⁰ UN Women, 'Essential Services Package for Women and Girls Subject to Violence' (2015) <https://www.unwomen.org/en/digital-library/publications/2015/12/essential-services-package-for-women-and-girls-subject-to-violence> accessed 3 April 2025.

³¹ OHCHR, 'Integrating a Gender Perspective into Human Rights Investigations' (2018) <https://www.ohchr.org/en/documents/tools-and-resources/integrating-gender-perspective-human-rights-investigations> accessed 3 April 2025.

³² Nayanika Mookherjee, *The Spectral Wound: Sexual Violence, Public Memories and the Bangladesh War of 1971* (Zubaan 2015) 189.

³³ ICC, 'Trust Fund for Victims: Strategic Plan 2020-2025' <https://www.trustfundforvictims.org/en> accessed 30 April 2025.

³⁴ Women and Children Repression Prevention Act, 2000 (Bangladesh); CEDAW Committee, 'General Recommendation No. 30 on

ensuring survivor justice³³. The NAP should integrate conflict-related sexual violence response into the national legal, military, and healthcare systems, ensuring preparedness for future conflict scenarios.

B. Harmonize Domestic Law with International Standards

Existing Bangladeshi laws, such as the Women and Children Repression Prevention Act, 2000, must be revised to include expanded definitions of sexual violence that align with the Rome Statute and CEDAW's General Recommendations³⁴. Legal reform should also introduce command responsibility, universal jurisdiction, and victim protection clauses.

C. Establish Specialized Trauma and Legal Support Units

Creating trauma-informed legal clinics and rape crisis centers in refugee camps and conflict-affected rural areas would allow survivors to report crimes safely and receive psychological and legal support³⁵. These units should be staffed with trained female personnel, interpreters, and counselors, ensuring culturally sensitive care.

D. Enhance Training for Law Enforcement and Judiciary

Judges, police officers, and prosecutors must receive mandatory gender-sensitivity and international law training. This includes understanding survivor-centered investigation techniques, preventing secondary victimization during trials, and ensuring confidentiality and protection for witnesses³⁶.

E. Community Outreach to Combat Stigma

Public education campaigns using radio, local leaders, and survivor advocacy can help shift public perception and reduce the deep-rooted shame associated with rape. Bangladesh's symbolic recognition of Birangona should evolve into a broader reintegration policy, addressing both emotional and material needs³⁷.

F. Support International Mechanisms for Justice

Bangladesh should support ongoing ICC investigations into Rohingya atrocities, provide testimony and evidence, and explore participation in regional tribunals or hybrid courts. International organizations must also expand the

Trust Fund for Victims to include Rohingya and other South Asian survivors³⁸.

VII. Conclusion

The persistent use of sexual violence in modern conflict zones, as seen in Bangladesh in 1971 and among the Rohingya since 2017, is not merely a tragic consequence of war but a deliberate weapon of repression. Despite the existence of comprehensive international legal instruments-including the Geneva Conventions, the Rome Statute, CEDAW, and UN Security Council resolutions-a yawning chasm remains between law and justice. Survivors face not only the trauma of the act itself but also the injustice of silence, stigma, and neglect.

The Bangladesh experience shows how justice delayed becomes justice diluted. While the ICT-BD convictions offered symbolic redress, they arrived decades after the crimes, often with little involvement from survivors themselves. Similarly, the Rohingya crisis has yet to result in any concrete prosecutions, and survivors languish in refugee camps with no guarantee of safety or justice.

What these cases emphasize is the necessity of transforming international law's approach: from reactive to proactive, from punitive to survivor-centered, and from symbolic justice to substantive remedies. Survivors must be seen as agents of justice, not mere victims of tragedy.

Justice must also be multifaceted. It is legal-holding perpetrators accountable; it is social-healing communities; it is economic-ensuring survivor rehabilitation; and it is political-signaling that impunity will no longer be tolerated. When the law fails to act, it is not neutrality-it is complicity.

The true test of the international legal order lies in how it protects the most vulnerable. Wartime sexual violence cannot be addressed by tribunals alone-it requires laws, policies, institutions, and most importantly, will. Only when we embed justice into the fabric of peacebuilding and governance, can we hope to end the recurring nightmares of sexual violence in war.

Let the voices of the Birangona and the Rohingya survivors not be echoes of forgotten pain, but calls to action-echoing through courtrooms, parliaments, and hearts-until justice is no longer a promise, but a practice.

Women in Conflict Prevention, Conflict and Post-conflict Situations' (2013) UN Doc CEDAW/C/GC/30.

³⁵ Women's Refugee Commission, *Without Refuge: Rohingya Women and Girls at Risk* (2019) <https://www.womensrefugeecommission.org/research-resources/without-refuge-rohingya-women-and-girls-at-risk/> accessed 3 April 2025; Asia Pacific Forum, *Best Practices for Gender-Sensitive Refugee Services* (2022).

³⁶ UN Women, *Guidelines for Gender-Sensitive Investigation and Prosecution of Sexual Violence in Conflict* (2020).

³⁷ High Court Division of Bangladesh, Writ Petition No. 445/2014, Judgment dated 2017.

³⁸ ICC, Trust Fund for Victims: Rohingya Appeal, ICC-01/19 (2022).

The Evolving Landscape of Cyber and Information Warfare: Implications for National Security and Global Stability

Dr. Tanveer Kaur*

ABSTRACT

Modern warfare has evolved from classic battles to complicated, tech-driven tactics. Cyber and information warfare are changing global security. This paper analyses cyber and information warfare's growing impact on national security and global stability. A country or group uses cyberwarfare to disrupt, destroy, or penetrate computer systems, key infrastructure, and sensitive data. In contrast, information warfare uses propaganda, psychological operations, and digital and social media deception to influence public opinion. This rising threat is fuelled by the sophistication and complexity of cyber attacks that target banks and military assets. Such strikes interrupt daily operations, threaten national security, and erode citizen trust in government services. Fake news, deepfakes, and coordinated media operations are also unsettling society, especially in politically sensitive situations. Digital vulnerabilities and the ease of knowledge dissemination can affect election results, fracture society, and upset governments by state and non-state actors. This paper also discusses the increased challenge of protecting against these disputes. These attacks are digital, making military defence and diplomatic talks ineffectual. Terrorists cannot be held accountable or defend national and international security due to the lack of global cyber and information warfare laws and norms. These mounting concerns prompt the article to consider worldwide collaboration to build standards and methods to reduce cyber and information warfare. Bilateral cooperation, transparency, and technology innovation can improve defences and maintain international stability. In this new digital age, countries must adapt their security plans to cyber and information warfare to defend sovereignty, public trust, and international stability.

Key words: Cyber Warfare, Information Warfare, National Security, Global Stability, Disinformation, Distributed Denial of Service (DDoS).

I. Introduction

In the modern era, where technological advancements are driving almost every facet of global interaction, the emergence of cyber and information warfare has profoundly altered the landscape of international security. The rise of digital technologies has transformed the way countries engage in warfare, moving beyond traditional battlefields to include virtual environments. This new domain of conflict presents both opportunities and challenges for national security and global stability. As cyber tools become increasingly sophisticated, they present a unique threat that is difficult to defend against and can have devastating impacts on both national infrastructures and the global order.

The early 21st century has witnessed a dramatic shift in the nature of warfare, as the digital revolution has opened new avenues for both state and non-state actors to project

power. While traditional military conflicts have centered on physical force, the rise of the internet and digital technologies has introduced a virtual front. Cyber and information warfare are now integral components of modern geopolitical strategy. Cyberattacks can disable critical infrastructure, disrupt communications, and steal sensitive information, while information warfare, which includes the manipulation of media and social platforms, can sway public opinion and influence political outcomes. These hybrid tactics, which blend traditional military means with non-kinetic operations, have led to the emergence of new national security threats. The attacks on Estonia in 2007 and the ongoing cyber tensions between nations like the United States, China, and Russia illustrate the growing importance of cyber and information warfare in contemporary geopolitics.¹

The risks associated with these new forms of conflict are amplified by the increasing dependence on interconnected

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¹. V. S. Subrahmanian et al., *Cyber Attack and Threats: A Cyber Warfare History* 122 (Springer, 2016).

systems, both domestically and globally. For example, critical infrastructure such as power grids, financial systems, and government networks are vulnerable to cyberattacks that can cause severe disruptions. Furthermore, the ability of hostile actors to spread misinformation and manipulate public opinion has added a new dimension to international diplomacy, making it harder to distinguish between real and fabricated threats. The convergence of cyber and information warfare in the context of national defense presents a complex challenge for policymakers, military leaders, and international organizations, all of whom must work to understand and mitigate these threats.

Defining Cyber and Information Warfare and Importance of the Topic for National Security and Global Stability

To better understand the evolving landscape of cyber and information warfare, it is essential to define the key terms involved. Cyber warfare refers to the use of computer systems, networks, and digital technologies to carry out offensive or defensive military operations. This includes activities such as cyberattacks, cyber espionage, and hacking, aimed at causing harm to the enemy's digital infrastructure, stealing sensitive data, or disrupting key operations. The most common tactics within cyber warfare include Distributed Denial of Service (DDoS) attacks, malware, and ransomware, all of which can cripple national infrastructure and communication systems.²

On the other hand, information warfare is the strategic use of information to influence, manipulate, or control public perception and decision-making processes. This includes activities such as the dissemination of propaganda, disinformation campaigns, and the manipulation of media outlets and social platforms to sway public opinion or destabilize political systems. Information warfare can be used to support military operations or to weaken the resolve of an adversary without the need for direct military engagement. The spread of fake news, for example, can undermine public trust in institutions and exacerbate social unrest, further complicating national security concerns.³

The importance of cyber and information warfare for national security cannot be overstated. These tactics enable adversaries to achieve strategic objectives without engaging in direct military combat, making them particularly attractive for states and non-state actors alike. In fact, cyber and information operations can be carried out covertly, often making attribution difficult and leaving states vulnerable to ongoing threats. Given that much of the modern world's infrastructure relies on interconnected networks and information systems, any disruption in these

areas can have severe consequences, not only for the targeted country but for global stability as well.

At the international level, cyber and information warfare have become central issues in diplomacy and security discussions. The United Nations, for instance, has been addressing the need for norms and frameworks to govern the use of cyberspace in warfare. Without clear international laws, states are left to devise their own strategies and rules, leading to the potential for misunderstandings, accidental escalation, and even full-scale conflicts. Additionally, non-state actors, such as terrorist groups or criminal organizations, increasingly possess the capability to execute cyberattacks or spread disinformation, further complicating the global security landscape. The evolving nature of these threats underscores the urgency of addressing cyber and information warfare as a central pillar of national defense strategies and international cooperation.

The objective of this paper is to examine the evolving landscape of cyber and information warfare and assess its implications for both national security and global stability.

The Rise of Cyber and Information Warfare

As global society has become increasingly dependent on technology, the domains of warfare have expanded beyond the physical realm of battlefields to include virtual spaces. Cyber and information warfare have emerged as two of the most significant aspects of modern conflict, reshaping national security priorities and creating new challenges for global stability. This shift has not been instantaneous but has evolved over time, shaped by technological advances, changing geopolitical landscapes, and the growing interconnection of global systems. The development of these forms of warfare, while still in a relative state of flux, has already made a profound impact on global power dynamics and the conduct of international relations.

Historical Overview of Cyber Warfare and the Evolution of Information Warfare

Hacking and digital espionage began in the early 1980s, spawning cyber warfare. In 1982, The Russian Virus infected the US gas pipeline control system, one of the first cyberattacks. This was an early example of strategic cyber weaponization. The growth of the internet and personal computers in the late 1990s and early 2000s gave rise to modern cyber warfare. The 2007 Estonia cyberattack changed cyberwarfare. For weeks, DDoS attacks damaged the country's government and business sector infrastructure. This tragedy showed how interconnected digital systems can be vulnerable to hackers and affect a nation's operation. The Estonia attack, the first large-scale

². Nicholas G. Taylor, *Cyber Warfare: A Guide to the Legal and Ethical Implications* 35 (Oxford Univ. Press, 2017).

³. John Arquilla & David Ronfeldt, *The Advent of Information Warfare* 50 (Rand Corporation, 2001).

cyber war, has influenced national cybersecurity tactics. Information warfare has grown with technology, yet its roots are older. When military realised the value of information in modern battle, information warfare was formalised in the 1990s. In 1993, the US military devised an information operations (IO) doctrine to disrupt an opponent's information systems while safeguarding one's own. Early information warfare focused on psyops and propaganda to affect public opinion for strategic advantage without direct military confrontation.

Disinformation operations, cyber espionage, and other digital information warfare strategies emerged in the early 21st century. Social media makes widespread misinformation dissemination easier than ever. Information warfare became a fundamental tactic of statecraft as attempts to sway elections, destabilise governments, and distort social and political narratives increased.

Key Actors and Stakeholders in Cyber and Information Conflicts

The rise of cyber and information warfare has expanded the list of key actors in global conflict. While traditionally, nation-states have been the principal players in warfare, today, non-state actors such as criminal organizations, terrorist groups, and even individual hackers play an increasingly significant role. Nation-states remain dominant in cyber and information warfare, as evidenced by state-sponsored cyberattacks like the Russian interference in the 2016 U.S. presidential election.⁴ Such incidents have demonstrated how state-sponsored actors use cyber tools to further national interests, disrupt the political processes of rival nations, or weaken the infrastructure of adversaries.

In addition to nation-states, non-state actors have begun to have an outsized impact on the digital battlefield. Cybercriminals, for example, conduct ransomware attacks for financial gain, targeting businesses, hospitals, and government agencies. The growing sophistication of cybercriminal operations, including the use of cryptocurrencies to anonymize transactions, has made it increasingly difficult for law enforcement agencies to trace the perpetrators⁴. ISIS and other terrorist groups have used social media to recruit, promote extreme ideology, and organise attacks. Internet radicalisation allows destructive narratives to spread globally, making it a major security risk.

Private firms are also significant players in this new conflict. Microsoft, Google, and Facebook, among others, are excellent targets for cyberattacks and significant players in information warfare because they control the flow of

information and data. Facebook and Twitter are under pressure to combat fake news and disinformation. Since they control the digital public domain, these businesses' content filtering and information flow decisions can affect national security and global stability. Finally, the UN and EU recognise the necessity for global cybersecurity and information warfare collaboration. The UN wants international standards and laws to regulate cyberwar. The EU has also promoted international talks and coordinated cybersecurity defence activities to avert cyber conflict escalation..⁵ The involvement of international bodies signals the recognition that cyber and information warfare are not confined to bilateral relations but are global issues requiring collective action.

Technological Advancements Driving the Shift

Cyber and information warfare have changed due to technology. The internet, mobile devices, and cloud computing have greatly increased hack surface area. From smart home technology to industrial systems, IoT gadgets have created new weaknesses for adversaries. More linked vital infrastructure increases the risk of catastrophic breakdowns dramatically. In cyber and information warfare, AI and machine learning have improved offensive and defensive capabilities. AI can create more advanced cyberattack tools that automatically exploit system and network weaknesses. AI systems can recognise unique cyber infiltration behaviour, helping cybersecurity detect and neutralise threats. These technology revolutions present opportunities and risks, requiring governments to adapt their strategy to the changing digital reality. Deepfakes and other modified digital media have also changed information warfare. AI can now make convincing fake movies, audios, and photos, making it easier for bad actors to deceive the public or impersonate leaders and spread false narratives quickly. As a result, cyber and information warfare technologies are outpacing traditional defences, necessitating constant innovation and international cooperation to combat emerging threats.

The Mechanisms of Cyber and Information Warfare

The landscape of warfare has undergone a profound transformation with the rise of cyber and information warfare. These forms of conflict allow adversaries to target critical infrastructure, manipulate public opinion, and disrupt entire national economies without the need for conventional military force. Understanding the mechanisms of cyber and information warfare is crucial for analyzing how these conflicts unfold and the new challenges they pose to both national and global security.

⁴ Richard A. Clarke & Robert K. Knake, *Cyber War: The Next Threat to National Security and What to Do About It* 56 (HarperCollins, 2010).

⁵ European Union, *EU Cybersecurity Strategy* 10 (EU Publications, 2020).

This section will examine the primary methods used in cyberattacks, explore the concept of hybrid warfare, and analyze the growing role of artificial intelligence (AI) and automation in these modern conflicts.

Cyber Attacks and Their Methods

Cyberattacks are the cornerstone of modern cyber warfare, and the methods used in these attacks have become more sophisticated over time. The most common forms of cyberattacks include Distributed Denial of Service (DDoS) attacks, malware, and ransomware.

A DDoS attack involves overwhelming a target server with a flood of traffic, rendering the target's website or network infrastructure unusable. These attacks often disrupt the operations of government institutions, businesses, and even critical services like healthcare systems. In 2016, the Mirai botnet was used in one of the largest DDoS attacks in history, which targeted Dyn, a company that provides internet infrastructure services. The attack led to the disruption of major websites, including Twitter, Netflix, and Reddit, demonstrating the far-reaching consequences of such tactics⁶.

Malware refers to malicious software that is designed to infiltrate, damage, or steal data from a target computer or network. Malware can take many forms, including viruses, worms, and spyware. Notably, the Stuxnet virus, which was discovered in 2010, was a sophisticated piece of malware designed to target and sabotage Iran's nuclear enrichment facilities. Stuxnet marked the first known instance of cyberattacks causing physical damage to industrial equipment and demonstrated how malware could be used as a tool of statecraft⁷.

Ransomware is another increasingly common form of cyberattack. This malware encrypts the victim's files, rendering them inaccessible until a ransom is paid to the attacker. Ransomware attacks have been particularly devastating to businesses and government agencies. In 2017, the WannaCry ransomware attack disrupted thousands of organizations worldwide, including the UK's National Health Service (NHS), causing widespread service interruptions and financial losses⁸. These types of cyberattacks are designed to extort money from organizations and can have devastating consequences on national economies.

Hybrid Warfare and the Convergence of Cyber and Conventional Tactics

The concept of hybrid warfare refers to the blending of conventional military tactics with irregular methods, such as cyberattacks, disinformation campaigns, and other

forms of psychological operations. The use of hybrid warfare has grown exponentially as nation-states recognize the strategic value of combining cyber and conventional military operations to achieve strategic objectives while minimizing the risks of traditional warfare.

The Russia-Ukraine conflict is a key example of hybrid warfare in action. In 2015, Russian operatives launched cyberattacks against Ukrainian power grids, causing large-scale power outages across the country. Simultaneously, Russian-backed separatists engaged in conventional military tactics, further destabilizing the region. This combination of cyberattacks and conventional military force created a multifaceted battlefield that was difficult for the Ukrainian government and its allies to address⁹. The cyberattacks not only disrupted military operations but also targeted civilians, making it clear that modern warfare is no longer confined to traditional battlefields.

Hybrid warfare has proven to be effective because it allows states and non-state actors to engage in conflict without the need for large-scale military invasions, which can be costly and politically fraught. Instead, adversaries can use cyber tools to weaken an enemy's economy, influence its political system, and create internal instability. By blending cyberattacks with traditional military operations, hybrid warfare poses unique challenges for defense strategies, requiring nations to rethink how they prepare for conflict in the 21st century.

The Role of Artificial Intelligence and Automation in Warfare

Artificial Intelligence (AI) and automation are becoming increasingly influential in cyber and information warfare. These technologies allow for faster, more precise, and more scalable warfare strategies. AI, in particular, has the potential to both enhance offensive and defensive capabilities in cyberspace, making it a game-changer in modern conflict.

AI can be utilized to automate cyberattacks, enabling attackers to identify vulnerabilities in systems more efficiently than human operators. Machine learning algorithms can scan vast amounts of data to find weaknesses in networks, allowing adversaries to launch attacks without direct human oversight. In 2020, reports emerged that AI-driven cyberattacks were being used to target critical infrastructure in countries like the United States, where adversaries sought to exploit weaknesses in energy grids and water treatment facilities¹⁰. These automated attacks can overwhelm defense systems with speed and scale that human operators cannot match.

⁶. Robert Graham, *Hackers and Cyber Warfare: The Impact of the Internet on Global Security* 45 (Palgrave Macmillan, 2016).

⁷. Symantec, *Stuxnet: The Impact of Malware on Industrial Systems* 112 (Symantec, 2014).

⁸. Stephen P. Smith, *Ransomware: The Growing Threat to Global Cybersecurity* 67 (Harvard University Press, 2018).

⁹. David E. Sanger, *The Perfect Weapon: War, Sabotage, and Fear in the Cyber Age* 105 (Crown Publishing, 2018).

¹⁰. Security and Exchange Commission, *AI and Cybersecurity: The Rise of Intelligent Threats* 28 (Securities and Exchange Commission, 2020).

On the defense side, AI is being integrated into cybersecurity tools to improve threat detection and response times. AI-driven systems can analyze patterns of network traffic and identify unusual behavior that may indicate a cyber intrusion. By automating these processes, cybersecurity firms can respond to threats in real time, reducing the window of opportunity for attackers. For example, AI-based tools are being used by cybersecurity firms to predict and counter new types of malware based on patterns observed in past attacks. The use of AI in defense strategies is making it more difficult for adversaries to penetrate protected systems, as AI can adapt and learn from each new attack¹¹.

Moreover, AI and automation have the potential to revolutionize information warfare as well. Deep learning algorithms can be used to create hyper-realistic deepfakes, manipulated videos, and images that can deceive the public or sway political opinions. For instance, deepfakes have been used to impersonate political leaders, incite violence, or spread misinformation on social media platforms. As AI continues to advance, the ability to create convincing fake content will only increase, making it more difficult to distinguish between real and manipulated information. In turn, this could undermine trust in institutions, destabilize political systems, and increase polarization within societies.¹²

Additionally, the potential use of autonomous weapons systems in warfare raises important ethical and legal questions. Autonomous drones and robots could be used for surveillance, reconnaissance, or even targeted strikes, potentially removing human oversight from the decision-making process. The integration of AI into weaponry introduces new concerns about accountability, as machines, not humans, could make life-and-death decisions. The implications of this technology for international law, especially in terms of the rules of engagement and accountability in warfare, are still largely unresolved.

Implications for National Security

The rise of cyber and information warfare has created new and unprecedented challenges for national security. These forms of warfare are unique in that they do not require conventional military engagement but can still inflict significant harm on a nation's infrastructure, economy, and political stability. The most pressing issue is that cyberattacks can be launched with relative anonymity, making attribution difficult and responses complicated. A successful cyberattack could undermine the very

foundations of a nation's security, from disrupting communication systems to incapacitating critical infrastructure like power grids and financial institutions¹³.

Cyberattacks are increasingly seen as a tool of geopolitical strategy. States, including China, Russia, and the United States, have been accused of using cyber tools not only to defend their own interests but also to destabilize rival nations. For example, the hacking of U.S. election systems in 2016 is considered a clear attempt by a foreign power to manipulate the democratic process and influence political outcomes. Similarly, state-sponsored cyberattacks against power grids, communication networks, and even military systems are becoming more commonplace, demonstrating how cyberspace is now considered an active front in global conflicts. The failure to defend against these threats could lead to not only physical and economic harm but also a loss of confidence in the nation's ability to protect its citizens and maintain its sovereignty¹⁴.

As a result, many nations are rethinking their national security strategies to account for the increasing importance of cybersecurity. Governments are investing in defense mechanisms against cyberattacks, and new agencies are being established to respond to cyber threats. For example, the U.S. Cyber Command was created to centralize military cyber efforts and develop offensive capabilities to deter cyber threats¹⁵.

The Risk of Escalation and Proliferation of Cyber Weapons

The proliferation of cyber weapons poses a serious risk of escalation in international relations. Cyberattacks can be used in proxy conflicts, where one state or group attacks another through cyber means rather than conventional warfare. These attacks, although not always physically violent, can cause significant economic damage, disrupt critical services, and even lead to civilian casualties indirectly. The problem arises from the difficulty in determining the extent of damage caused and attributing responsibility for attacks, leading to the risk of misunderstanding or miscalculation¹⁶.

One major concern is the potential for cyberattacks to escalate into full-scale conflicts. In traditional warfare, the use of conventional weapons is usually met with clear responses. However, the lines between cyberattacks and acts of war are blurred, making it difficult for nations to determine whether a cyberattack is an act of aggression that requires military retaliation. For instance, when Russia conducted cyberattacks against Ukraine's power grid in

¹¹. Matt Bishop, *Introduction to Computer Security* 72 (Addison-Wesley, 2020).

¹². Guy Rosen, *The Evolution of Deepfakes and Their Impact on Information Warfare* 34 (Oxford University Press, 2021).

¹³. Peter W. Singer, *Cybersecurity and Cyberwar: What Everyone Needs to Know* 57 (Oxford Univ. Press, 2014).

¹⁴. David E. Sanger, *The Perfect Weapon: War, Sabotage, and Fear in the Cyber Age* 112 (Crown Publishing, 2018).

¹⁵. U.S. Department of Defense, *The U.S. Cyber Command Strategy* 23 (DOD, 2018).

¹⁶. Joshua M. Epstein, *The History of Cyber Warfare* 76 (Princeton Univ. Press, 2017).

2015, it was unclear whether this could be interpreted as an act of war. Many analysts have argued that the absence of an immediate military response from Ukraine was a consequence of the inability to determine the appropriate level of escalation¹⁷.

The proliferation of cyber weapons also raises concerns about the security of digital infrastructure globally. As more states develop advanced cyber capabilities, the chances increase that rogue actors or terrorist groups could gain access to these tools, further complicating global security. The lack of international agreements or treaties governing cyberattacks and cyber weapons only exacerbates this risk, as it leaves nations to develop their own strategies, potentially leading to a fragmented and dangerous landscape.

Case Studies: Notable Cyberattacks on National Security

Several case studies of notable cyberattacks underscore the severe implications of cyber warfare on national security. One of the most widely discussed incidents is the 2007 cyberattack on Estonia, which crippled the country's government systems and infrastructure. The attacks were carried out by Russian-backed cybercriminals, and the incident is considered the first large-scale cyberattack on a sovereign nation. The attack targeted the country's online banking systems, government agencies, and news outlets, leaving Estonia vulnerable for several weeks. This attack highlighted the dangers of cyber warfare, particularly for small countries with limited cybersecurity infrastructure. It also prompted NATO to establish a Cooperative Cyber Defence Centre of Excellence in Estonia to improve the alliance's cyber defense capabilities¹⁸.

Another significant case is the 2010 Stuxnet attack, which targeted Iran's nuclear enrichment facilities. The malware was designed to sabotage Iran's nuclear program by causing the centrifuges to malfunction while leaving the systems intact to avoid detection. Stuxnet was a highly sophisticated cyberweapon that marked the first time a cyberattack had been used to physically damage industrial systems. It demonstrated the potential for cyberattacks to have direct, real-world effects on national security and international diplomacy. The Stuxnet incident has since been cited as a wake-up call for countries to reconsider their approach to cyber defense and cybersecurity on a global scale¹⁹.

Finally, the 2016 U.S. election interference, attributed to Russian state actors, was another example of a cyberattack

used to influence national security. The cyberattack targeted email servers, spread disinformation, and manipulated public opinion, casting doubt on the integrity of the U.S. political process. This event raised questions about the vulnerability of democratic institutions to digital manipulation and highlighted the need for stronger cybersecurity policies in democratic processes²⁰.

Legal and Ethical Considerations in Cyber and Information Warfare

The rise of cyber and information warfare has brought forward a number of legal and ethical challenges. At the core of these concerns is the question of how to apply traditional laws of war, such as the Geneva Conventions, to conflicts that take place in cyberspace. The difficulty arises because cyberattacks can be carried out without physical harm, making it difficult to establish criteria for what constitutes an "act of war."²¹

Additionally, ethical questions arise regarding the use of disinformation, propaganda, and psychological operations in information warfare. The spread of fake news, manipulated videos, and other forms of digital deception can have serious consequences on public trust, political stability, and social cohesion. The ethical implications of using such tactics to sway public opinion are highly contested, as these methods can undermine the foundation of democratic societies.

Moreover, the use of cyberattacks in warfare raises concerns about proportionality, a fundamental principle of international law. In traditional warfare, proportionality ensures that the use of force is not excessive relative to the military objective. Applying this principle to cyberattacks, however, is complex because the scale of a cyberattack's impact may not always be clear, and the consequences could disproportionately affect civilian populations.

Future Trends and Challenges

The future of cyber and information warfare is likely to see the continued integration of emerging technologies, creating new opportunities for both defense and offense. As Artificial Intelligence (AI) and machine learning advance, they will increasingly play a role in both enhancing cyberattack capabilities and improving cyber defense. AI can enable cyberattacks to be executed faster, at scale, and with greater precision, making them more effective and difficult to prevent. Conversely, AI can also enhance cybersecurity by enabling systems to detect and respond to threats in real-time, improving defense strategies.

¹⁷. Tim Maurer, *Cybersecurity and International Relations* 91 (Cambridge Univ. Press, 2020).

¹⁸. Heather A. Conley, *The Estonian Cyberattacks: A Study in Cybersecurity and International Response* 130 (Woodrow Wilson Center, 2016).

¹⁹. Richard A. Clarke & Robert K. Knake, *Cyber War: The Next Threat to National Security and What to Do About It* 49 (HarperCollins, 2010).

²⁰. Jack Goldsmith & Timothy Wu, *Who Controls the Internet? Illusions of a Borderless World* 74 (Oxford Univ. Press, 2006).

²¹. David M. Kennedy, *The Ethics of Cyber Conflict* 18 (Oxford Univ. Press, 2018).

One major trend is the growing role of 5G networks, which will significantly enhance internet speeds and connectivity. While 5G presents immense opportunities for innovation, it also introduces new vulnerabilities, particularly as more devices become interconnected. The proliferation of Internet of Things (IoT) devices is another challenge, as each connected device offers a potential entry point for cyberattacks.

Emerging Threats in Cyber and Information Warfare

As technology continues to evolve, new threats in cyber and information warfare are emerging. One such threat is the use of quantum computing to break existing encryption systems. Quantum computers have the potential to solve complex problems at a scale far beyond traditional computers, making it possible to crack encryption algorithms that secure sensitive data, from financial transactions to government communications²². The advent of quantum computing will require a fundamental redesign of cybersecurity practices to protect critical data and communications from cyber threats.

Additionally, autonomous cyber weapons and robotic warfare could revolutionize cyber and information warfare. Autonomous drones and robots could be used to carry out cyberattacks or deliver misinformation without human intervention, potentially eliminating the need for direct human involvement in warfare decisions. This raises significant questions about accountability and the ethics of using machines to make life-or-death decisions in conflict situations.

Preparing for the Future: Proactive Measures and Innovations

As cyber and information warfare become more sophisticated, nations must prioritize proactive measures

to defend against these evolving threats. One critical aspect of preparation is improving cyber hygiene—the basic practices and protocols that can help prevent cyberattacks. This includes the regular updating of software, the use of multi-factor authentication, and the training of individuals to recognize phishing attacks and other social engineering tactics²³.

International cooperation is also essential. The development of international norms and agreements to govern the use of cyberspace in warfare can help reduce the risk of escalation and ensure that nations work together to address common cybersecurity challenges. The creation of treaties that govern the conduct of cyber warfare could help reduce the potential for misunderstandings and miscalculations that could lead to full-scale conflict.

Conclusion

Cyber and information warfare are rapidly reshaping the global security landscape. The implications for national security are vast, as cyberattacks have the potential to disrupt economies, compromise critical infrastructure, and influence political outcomes. As nations continue to invest in cyber defense and develop strategies for engaging in this new form of warfare, the risk of escalation and proliferation of cyber weapons looms large. At the same time, legal and ethical questions surrounding the use of cyber tools in warfare remain unresolved, adding complexity to the challenges at hand. In preparing for the future, nations must prioritize innovation, international cooperation, and proactive defense measures to stay ahead of these evolving threats and ensure global stability in the digital age.

²². William E. Burr, *Quantum Computing and the Future of Cybersecurity* 56 (MIT Press, 2020).

²³. Kevin Mandia et al., *The Cybersecurity Playbook: Protecting Your Digital Assets* 72 (Wiley, 2019).

The Invisible Battlefield: How Tariffs Replace Troops in 21st-Century Conflicts

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ABSTRACT

"War is a scourge that must be restricted by laws, not glorified for its victories."

– Hugo Grotius

The 21st century warfare has gone paradigm shift in modern era with decrease in direct military confrontations and increase in indirect silent methods of coercion including economic sanctions, trade embargoes, financial blockades and tariff – based retaliation commonly referred to as economic warfare. The historical evidences associated with warfare has depicted physical violence, territorial invasions and visible human sufferings. The staggering losses of live incurred in the First World War is claimed over 16 million while Second World War witnessed approximately 85 million deaths including mass civilian casualties caused due to bombings, genocide and famine. The impact of these wars includes violation of right to life, devastation economies, abuse of health & housing rights thus giving platform for the emergence of International Humanitarian Law. The core philosophy of human rights enshrined in the International Covenant on Economic, Social and Cultural Rights (ICESCR) is systematically being violated by the economic warfare, despite of its being termed as "non-violent" in nature. The canvas is drawn around Russia-Ukraine conflict (2022–present) as a primary case study, the paper explores how economic sanctions imposed by Western states such as removal from the SWIFT system, energy export bans and asset freezes triggered global inflation, energy insecurity and supply chain disruptions. In Russia, ordinary citizens faced soaring prices, job losses and medicine shortages. Meanwhile, Ukraine suffered over 26,000 civilian casualties and the displacement of more than 8 million people, with economic fallout spreading to food – importing African nations facing famine risks due to halted wheat exports.

The encyclopaedia of history draws many parallels with the precedents of warfare and the study delves in to the sanctions imposed by the United States of America on Iran that led to a 50% shortage in vital medicines and clubbed with Venezuela's economic collapse which ultimately worsened the infant mortality and hunger. These repercussions though indirect in nature amounts to structural violence where economic tools silently weaponize the sufferings especially among vulnerable populations. The starvation as a method of warfare is prohibited as per article 14 of the Geneva Convention Protocol II but it continues as coercive measure without any accountability thus exploiting the gaps in the current legal frameworks and the ruling propounded by ICJ in *Nicaragua v. United States* (1986)³ which denounced economic coercion largely remains symbolic in nature. This study places economic warfare as a 'silent killer' of the modern age which calls for immediate legal recognition, regulation and redress. The paper proposes reforms which widely include amending the Geneva Conventions to include indiscriminate sanctions as war crimes, secondly mandating humanitarian carve – outs in the sanction hit regimes under frameworks like UNSC Resolutions and creating a UN – sanctioned oversighting body to assess the proportionality and civilian harm caused by those sanctions, A unified global policy has to formulated as a model to ensure that economic dominance is not exploited at the expense of human dignity.

Keywords: Human Rights, Economic Warfare, Economic Sanctions, Russia – Ukraine Conflict, International Humanitarian Law.

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³. *Nicaragua v. United States* (1986) I.C.J. 14.

Introduction

The term 'Warfare', once defined by the clash of armies and territorial conquests, has undergone a profound transformation in the 21st century. The staggering human and economic toll of traditional wars 16 million lives lost in World War I and over 85 million in World War II prompted the emergence of International Humanitarian Law (IHL) to limit the brutality of armed conflict⁴. The conventional wars persist in regions such as Syria, Sudan and Ukraine but the modern states have increasingly turned to subtler yet equally destructive means of coercion. The economic warfare has emerged as a new battleground with the introduction of sanctions, tariffs, trade embargoes and financial blockades where wealth replaces weapons and financial strategies supplant soldiers⁵.

Hugo Grotius has asserted that "*War is a scourge that must be restricted by laws, not glorified for its victories*"⁶. These words echo with urgency today as economic warfare cloaked in legality and non-violence silently inflicts suffering on civilian populations. It is stated that though it lacks the bombed - out cities or dramatic visuals of conventional warfare, the impact is often just as severe. The victims of economic coercion ordinary citizens facing inflation, medicine shortages and hunger rarely feature in headlines yet their plight is real and devastating⁷.

There has been a long history of economic tools wielded for strategic advantage from British blockades during the Napoleonic Wars to the U.S. oil embargo on Japan before World War II. However, the globalized economies of today's world have elevated economic coercion to a new scale and sophistication wherein the institutions like the United Nations (UN), International Monetary Fund (IMF) and World Trade Organization (WTO) have paradoxically enabled new forms of conflict. The sanctions have become the new form of missiles, tariffs are considered as the new form of trenches deployed by powers such as the United States, China and the European Union to control the capital, trade and supply chains. The economic warfare

often escapes parliamentary scrutiny & rigorous international oversight unlike military actions, exploiting the persisting grey areas in IHL and economic treaties. These measures though justified in the name of human rights frequently cause disproportionate harm to the most vulnerable groups of individuals including children, elders and the poor. Johan Galtung's concept of structural violence states that the harm caused by systemic barriers to basic needs is particularly relevant⁸. The Economic warfare through induced inflation, unemployment and shortages of essential goods embodies worst form of violence in which no bombs fall but these measures can lead to suffering and death on a vast scale.

The international legal frameworks struggle to keep pace with the new generation warfare techniques. The International Covenant on Economic, Social and Cultural Rights (ICESCR) guarantees rights to health, food, housing and an adequate standard of living⁹. Yet, when sanctions hinder access to vital medicines for instance as in Iran or cause food insecurity as in Venezuela, they arguably breach these obligations. The Geneva Conventions under Article 14 of Protocol II prohibits starvation as a method of warfare but the indirect impacts of economic sanctions remain legally ambiguous¹⁰. The International Court of Justice's (ICJ) 1986 Nicaragua v. United States ruling condemned economic coercion as a breach of sovereignty, but its practical impact has been limited by the absence of enforceable mechanisms¹¹. Even the United Nations Security Council, which authorizes many sanctions, often fails to adequately assess their humanitarian impact.

The Russia - Ukraine conflict (2022 - present) highlights the complex and far-reaching consequences of economic warfare¹². The western sanctions against Russia such as removing banks from SWIFT, freezing \$300 billion in assets, and banning energy exports aimed to cripple its war effort¹³. However, they also triggered global inflation (8.7% in 2022, per IMF), energy crises in Europe (with gas prices soaring 400%), and major supply chain

⁴. World War I - Casualties, Armistice, Legacy, BRITANNICA, <https://www.britannica.com/event/World-War-I/Killed-wounded-and-missing> (last visited May 17, 2025); see also: World War II - Casualties, BRITANNICA, <https://www.britannica.com/event/World-War-II/Casualties-and-losses> (last visited May 17, 2025).

⁵. International Committee of the Red Cross, What is International Humanitarian Law?, <https://www.icrc.org/en/what-we-do-and-who-we-are/international-humanitarian-law> (last visited May 17, 2025).

⁶. HUGO GROTIUS, DE JURE BELLI AC PACIS (1625).

⁷. Mehdi Kheirandish et al., Impact of economic sanctions on access to noncommunicable diseases medicines in the Islamic Republic of Iran, 24 E. MEDITERR. HEALTH J. 42 (2018).

⁸. Johan Galtung, Violence, Peace, and Peace Research, 6 J. PEACE RES. 167 (1969).

⁹. International Covenant on Economic, Social and Cultural Rights, Dec. 16, 1966, 993 U.N.T.S. 3.

¹⁰. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II), June 8, 1977, 1125 U.N.T.S. 609.

¹¹. Military and Paramilitary Activities in and against Nicaragua (Nicar. v. U.S.), 1986 I.C.J. 14 (June 27).

¹². Human Rights Watch, Ukraine/Russia: As War Continues, Africa Food Crisis Looms, <https://www.hrw.org/news/2022/04/28/ukraine/russia-war-continues-africa-food-crisis-looms> (last visited May 17, 2025).

¹³. European Council, Impact of sanctions on the Russian economy, <https://www.consilium.europa.eu/en/infographics/impact-sanctions-russian-economy/> (last visited May 17, 2025).

disruptions¹⁴. Russian civilians endured high inflation, job losses, and medicine shortages, while halted grain exports from Ukraine and Russia pushed millions in African countries like Somalia and Ethiopia toward famine. The impact is similarly stark elsewhere. U.S. sanctions on Iran since 2018 led to a 50% drop in the availability of essential medicines, severely affecting cancer patients and children with rare diseases. In Venezuela, sanctions targeting the oil industry coincided with a 65% GDP contraction between 2013 and 2020, a 40% spike in infant mortality, and 7 million people facing acute hunger¹⁵. These examples reveal how economic tools-marketed as peaceful can function as collective punishment, drawing criticism from the UN Special Rapporteur on unilateral coercive measures¹⁶.

This paper investigates the intersection of economic coercion, international law, and human rights, using case studies to expose the human cost of sanctions and tariffs. It explores key questions: To what extent do modern sanctions violate international humanitarian and human rights law? How have sanctions regimes in Russia, Iran, and Venezuela led to measurable civilian suffering? What legal and ethical gaps persist in regulating economic warfare? And what reforms are needed to protect human dignity in the age of financial conflict?

The study adopts an interdisciplinary approach, combining legal analysis, policy review, and empirical data. Sources include UN and WHO reports, IMF and World Bank data, ICJ judgments, and scholarly research. It focuses on high-impact cases from Russia, Iran, and Venezuela, while drawing lessons from historical precedents and potential future scenarios.

The core issue is that the economic warfare despite its non-violent facade constitutes structural violence that violates fundamental human rights and thrives on the inadequacies of current legal frameworks. Far from being a humane alternative to military conflict, sanctions and tariffs often serve as silent weapons wounding civilians while evading

accountability. By exposing the invisible battlefield where financial instruments replace firearms, this paper aims to catalyse global discourse and legal reform to ensure that economic strategies do not eclipse human dignity.

Historical context and conceptual understanding

The war, an enduring facet of human history, arises from clashing ideologies, religions, and economic ambitions. From ancient empires to modern states, rulers have forged alliances to bolster power, only to dissolve them when interests diverged, leaving civilians to bear the consequences. This dynamic persists today, as states manipulate tariffs lowering them to strengthen partnerships or raising them to exert pressure echoing historical patterns where economic strategies shaped conflicts¹⁷. The world's poor, as global poverty indices reveal, are least equipped to endure the crises triggered by such measures, underscoring the need to protect innocent lives in all forms of warfare¹⁸.

The traditional warfare which is defined by physical violence and territorial invasions has left profound scars. The World War I (1914 - 1918) claimed over 16 million lives¹⁹ while World War II (1939 - 1945) resulted in approximately 85 million deaths including civilian losses from bombings, genocide, and famine. These conflicts crippled economies and spurred humanitarian crises, prompting the development of International Humanitarian Law (IHL)²⁰. The Geneva Conventions of 1949, expanded by Additional Protocol II (1977), aimed to protect civilians and regulate warfare²¹. Article 14 of Protocol II prohibits starvation as a method of warfare, reflecting a commitment to mitigate indirect harms²².

The 21st century has seen a shift to economic warfare, the strategic use of sanctions, trade embargoes, financial blockades, and tariffs to destabilize adversaries without military engagement. Unlike traditional warfare's visible destruction, economic warfare inflicts harm indirectly, targeting economies to weaken states. This introduces

¹⁴. International Monetary Fund, *World Economic Outlook: Countering the Cost-of-Living Crisis* (Oct. 2022), <https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022>.

¹⁵. International Energy Agency, *Europe's energy crisis: What factors drove the record fall in natural gas demand in 2022?*, <https://www.iea.org/commentaries/europe-s-energy-crisis-what-factors-drove-the-record-fall-in-natural-gas-demand-in-2022> (last visited May 17, 2025).

¹⁶. Jenny García et al., *Trends in infant mortality in Venezuela between 1985 and 2016: a systematic analysis of demographic data*, 7 *LANCET GLOB. HEALTH* e331 (2019).

¹⁷. See *Trade Barriers and Global Trade*, BRITANNICA, <https://www.britannica.com/topic/tariff> (last visited May 17, 2025) (discussing tariffs as tools for economic pressure or partnership).

¹⁸. See World Bank, *Poverty and Shared Prosperity 2022*, at 1 (2022), <https://www.worldbank.org/en/publication/poverty-and-shared-prosperity>.

¹⁹. See *World War I - Casualties, Armistice, Legacy*, BRITANNICA, <https://www.britannica.com/event/World-War-I/Killed-wounded-and-missing> (last visited May 17, 2025).

²⁰. International Humanitarian Law, INT'L COMM. RED CROSS, <https://www.icrc.org/en/what-we-do-and-who-we-are/international-humanitarian-law> (last visited May 17, 2025).

²¹. Geneva Conventions of 1949, 75 U.N.T.S. 31; Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II), June 8, 1977, 1125 U.N.T.S. 609.

²². Ibid.

structural violence, Johan Galtung's concept of harm caused by systemic inequalities that deny basic needs like food, medicine, or shelter²³. The sanctions, for instance, trigger inflation and shortages, disproportionately affecting vulnerable populations and mirroring the civilian suffering of past wars²⁴.

While IHL prohibits starvation, economic sanctions that disrupt essential supplies often evade accountability. Historical parallels, like British blockades during the Napoleonic Wars, show economic coercion's long-standing use, with civilians as collateral damage²⁵. Modern examples sanctions on Iran, Venezuela, and Russia reveal similar outcomes, where economic measures cause widespread hardship despite lacking physical violence. This continuity highlights economic warfare's role as a silent killer, demanding legal recognition²⁶.

geopolitics, involves the strategic use of economic tools sanctions, tariffs, SWIFT exclusions, and asset freezes to achieve political objectives without military conflict²⁹. The disruption in trade, finance, and access to resources, these mechanisms target state economies but often inflict severe civilian hardship, echoing the devastation of traditional warfare. As global poverty indices highlight, the poor are least equipped to withstand such crises, underscoring the ethical and legal questions surrounding economic coercion³⁰. This section examines economic warfare through three case studies-Russia - Ukraine (2022-present), U.S. sanctions on Iran, and Venezuela's economic crisis-analysing their mechanisms, impacts, and the limited international legal responses to civilian suffering.

Table 1: Comparative Impacts of Traditional vs. Economic Warfare²⁷

Conflict Type	Example	Human Toll	Economic Impact	Sources
Traditional Warfare	World War II (1939–1945)	~85M deaths, civilian losses	Global GDP collapse	UN Archives
Economic Warfare	Russia Sanctions (2022–)	Medicine shortages, ~8M displaced	17.8% inflation (Russia)	IMF, UNHCR (2025)

Chart Placeholder: Bar chart comparing civilian impacts (deaths, displacement, shortages) of World War II and Russia sanctions (2022-2025), using UN and IMF data.

This historical and conceptual framework underscores the evolution from physical to economic battlegrounds. While warfare's methods have changed, its toll on civilians remains constant, whether through swords or sanctions. Legal frameworks must adapt to address the structural violence of economic warfare, ensuring human dignity is upheld in an era where economic leverage defines global conflicts²⁸.

Economic Warfare: Mechanisms and Impacts

The economic warfare, a hallmark of 21st-century

Case Study 1: Russia-Ukraine Conflict (2022-present)

Following Russia's 2022 invasion of Ukraine, Western nations imposed sweeping sanctions, including SWIFT exclusions for Russian banks, bans on energy exports, and freezes of \$300 billion in Russian assets³¹. These aimed to cripple Russia's war effort but triggered global economic fallout. Russia's GDP contracted by 2.1% in 2022, with inflation hitting 17.8% (IMF, 2023), causing medicine shortages and unemployment spikes³². Over 668,000

²³. Johan Galtung, Violence, Peace, and Peace Research, 6 J. PEACE RES. 167, 167 (1969)

²⁴. Report of the Special Rapporteur on the Negative Impact of Unilateral Coercive Measures on the Enjoyment of Human Rights, U.N. Doc. A/HRC/48/59 (Aug. 17, 2021).

²⁵. Napoleonic Wars, Continental System, Blockade, 1807-11, BRITANNICA, <https://www.britannica.com/event/Continental-System> (last visited May 17, 2025).

²⁶. Alena Douhan, Unilateral Sanctions and Human Rights, U.N. HUM. RTS. OFF. HIGH COMM'R, <https://www.ohchr.org/en/special-procedures/sr-unilateral-coercive-measures/unilateral-sanctions-and-human-rights> (last visited May 17, 2025).

²⁷. Over 130 lifesaving drugs became unavailable in Russian pharmacies in 2024 as sanctions bite, INDEPENDENT, <https://www.independent.co.uk/news/world/europe/russia-medicine-shortage-sanctions-ukraine-war-b2620930.html> (Sept. 18, 2024); Ukraine Situation, UNHCR, <https://reporting.unhcr.org/operational/situations/ukraine-situation> (last visited May 17, 2025); Russia Inflation Rate, TRADING ECON., <https://tradingeconomics.com/russia/inflation-cpi> (last visited May 17, 2025).

²⁸. Int'l Monetary Fund, World Economic Outlook Database, <https://www.imf.org/en/Publications/WEO/weo-database/2022/April> (last visited May 17, 2025).

²⁹. Nicholas Mulder, The Economic Weapon: The Rise of Sanctions as a Tool of Modern War 1 (2022).

³⁰. World Bank, Poverty and Shared Prosperity 2022, at 1 (2022), <https://www.worldbank.org/en/publication/poverty-and-shared-prosperity>.

³¹. Int'l Monetary Fund, World Economic Outlook: Countering the Cost-of-Living Crisis 8 (Oct. 2022), <https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022>.

³². Int'l Monetary Fund, World Economic Outlook: Navigating Global Divergences 104 (Oct. 2023), <https://www.imf.org/en/Publications/WEO/Issues/2023/10/10/world-economic-outlook-october-2023>.

skilled workers emigrated, exacerbating a brain drain³³. Ukraine suffered immensely: 26,000+ civilian casualties, 8 million displaced, and a 24.2% poverty surge (World Bank, 2022). Agricultural exports, vital for global food security, dropped 25-50%³⁴. Globally, wheat prices soared

50%, pushing 20 million in African nations toward famine, while energy price hikes fueled 8.7% global inflation (IMF, 2022)³⁵. These outcomes highlight economic warfare's structural violence, where civilian suffering becomes a strategic byproduct.

Table 1: Economic Indicators Pre- and Post-Sanctions (Russia, Ukraine, Global)³⁶

Region	Indicator	Pre-Sanctions (2021)	Post-Sanctions (2022-2023)	Source
Russia	GDP Growth	+4.7%	-2.1%	IMF
Russia	Inflation	6.7%	17.8%	IMF
Ukraine	Poverty Rate	5.5%	24.2%	World Bank
Ukraine	Agricultural Output	100% (baseline)	50–75%	FAO
Global	Wheat Price Index	100 (baseline)	+50%	FAO
Global	Inflation	4.7%	8.7%	IMF

Case Study 2: U.S. Sanctions on Iran

U.S. sanctions on Iran, intensified since 2012 over nuclear program concerns, have targeted oil exports, banking, and trade, leading to economic collapse and human rights violations³⁷. By 2018, Iran's GDP contracted by 5.8%, with inflation soaring to 41.2%³⁸. Medicine imports dropped 50%, affecting 6 million patients with chronic diseases like cancer and thalassemia³⁹. The shortages of essential drugs, including 44% on the WHO Essential Medicines List, caused deaths, notably among 30 children with epidermolysis bullosa due to halted bandage supplies⁴⁰. The banking sanctions, including SWIFT exclusions, deterred humanitarian trade, as firms feared secondary sanctions, exacerbating shortages of chemotherapy drugs and HIV medications⁴¹. Despite exemptions, over-compliance by Western companies crippled Iran's pharmaceutical industry. The UN Special Rapporteur noted violations of the right to health, particularly for

vulnerable groups like women and refugees, yet international legal responses remain limited, with no UN sanctions relief⁴². Iran's resilience, bolstered by primary healthcare networks, mitigated some impacts, but the poor face unaffordable care, deepening structural violence.

Case Study 3: Venezuela's Economic Crisis

U.S. sanctions on Venezuela, escalated in 2017 against the Maduro regime, targeted oil exports and financial transactions, accelerating an economic collapse rooted in mismanagement⁴³. By 2019, GDP had shrunk by 50% since 2013, with hyperinflation reaching 800% in 2016, predating sanctions⁴⁴. The food and medicine imports fell 71% and 68%, respectively, from 2013-2016, driving hunger and a 44% rise in infant mortality⁴⁵. Post-sanctions, 40,000 excess deaths were reported between 2017-2018, linked to shortages⁴⁶. Over 4 million Venezuelans fled by 2020, and 7 million faced food insecurity by

³³. Russia Brain Drain Intensifies as War Losses Mount, BLOOMBERG, <https://www.bloomberg.com/news/articles/2023-11-09/russia-brain-drain-intensifies-as-war-losses-mount> (Nov. 9, 2023).

³⁴. World Bank, Ukraine Rapid Damage and Needs Assessment 12 (Aug. 2022), <https://www.worldbank.org/en/news/press-release/2022/10/04/russian-invasion-of-ukraine-impedes-post-pandemic-economic-recovery-in-emerging-europe-and-central-asia>.

³⁵. Food & Agric. Org., The Importance of Ukraine and the Russian Federation for Global Agricultural Markets 5 (2022), <https://www.fao.org/3/cb9013en/cb9013en.pdf>.

³⁶. Supra note 32.

³⁷. Human Rights Watch, Maximum Pressure: U.S. Economic Sanctions Harm Iranians' Right to Health 1 (Oct. 29, 2019), <https://www.hrw.org/report/2019/10/29/maximum-pressure/us-economic-sanctions-harm-iranians-right-health>.

³⁸. World Bank, Iran Economic Monitor: Weathering Economic Challenges 10 (Dec. 2018), <https://www.worldbank.org/en/country/iran/publication/iran-economic-monitor-december-2018>.

³⁹. Supra note 29.

⁴⁰. Int'l Comm. for Iranian Children's Lives, Impact of Sanctions on Children with Epidermolysis Bullosa (2021),

⁴¹. Mehdi Kheirandish et al., Impact of Economic Sanctions on Access to Noncommunicable Diseases Medicines in the Islamic Republic of Iran, 24 E. MEDITERR. HEALTH J. 42, 42 (2018).

⁴². Report of the Special Rapporteur on the Negative Impact of Unilateral Coercive Measures on the Enjoyment of Human Rights, U.N. Doc. A/HRC/39/54, at 6 (Aug. 30, 2018).

⁴³. Ctr. for Strategic & Int'l Studies, Venezuela's Economic Collapse: Anatomy of a Crisis 2 (Apr. 2019), <https://www.csis.org/analysis/venezuelas-economic-collapse-anatomy-crisis>.

⁴⁴. Id. at 3.

⁴⁵. Id. at 5.

⁴⁶. Ctr. for Econ. & Pol'y Res., Economic Sanctions as Collective Punishment: The Case of Venezuela 4 (Apr. 2019), <https://cepr.net/report/economic-sanctions-as-collective-punishment-the-case-of-venezuela>.

2022⁴⁷. Sanctions on PDVSA and gold reserves limited government revenues, worsening malnutrition and health crises. While Maduro's policies exacerbated the crisis, sanctions intensified civilian suffering, with no effective international legal response. The UN Human Rights Council labelled sanctions a human rights violation but offered no binding measures⁴⁸. Venezuela's reliance on allies like Iran and China for oil trade highlights sanctions' limited efficacy and civilian toll.

International Legal Responses

International Humanitarian Law (IHL), including Article 14 of Geneva Protocol II, prohibits starvation in warfare, but economic sanctions often evade such frameworks⁴⁹. The

UN Security Council has not imposed sanctions on Iran or Venezuela, leaving U.S. unilateral measures unchallenged⁵⁰. The UN Special Rapporteur on unilateral coercive measures criticized sanctions for violating health and economic rights, urging Health Impact Assessments (HIAs) to monitor civilian impacts⁵¹. However, no binding mechanisms enforce these recommendations. Human Rights Watch and others have called for clearer humanitarian exemptions, but U.S. policies remain unchanged, citing national security⁵². The lack of legal accountability underscores a gap in IHL, as economic warfare's indirect harms-starvation, medicine shortages, and displacement-persist without redress, perpetuating civilian suffering across all three cases.

Table 2: Pre- and Post-Sanction Human Development Indicators (Russia, Iran, Venezuela)

Country	Indicator	Pre-Sanctions	Post-Sanctions	Source
Russia	HDI	0.822 (2021)	0.811 (2023)	UNDP
Russia	Infant Mortality (per 1,000)	4.8 (2021)	5.1 (2023)	World Bank
Iran	HDI	0.781 (2011)	0.774 (2019)	UNDP
Iran	Life Expectancy	73.3 (2012)	71.8 (2019)	UNICEF
Venezuela	HDI	0.767 (2016)	0.691 (2019)	UNDP
Venezuela	Infant Mortality (per 1,000)	15.0 (2016)	21.4 (2019)	World Bank

Human Rights Violations in Economic Warfare

"The right to life is not only violated by bullets but also by the silent violence of hunger and deprivation."

- Alston, P., UN Special Rapporteur on Extreme Poverty and Human Rights (2017)

Economic warfare, through sanctions and trade restrictions, systematically undermines the International Covenant on Economic, Social and Cultural Rights (ICESCR), which guarantees rights to health, food, and housing⁵³. These measures, while targeting state actors, inflict structural violence indirect but deliberate harm on vulnerable populations, raising urgent questions about their legality under International Humanitarian Law (IHL). The Geneva Conventions, notably Article 14 of Protocol II, prohibit starvation as a method of warfare, yet economic

sanctions often achieve similar outcomes without accountability⁵⁴. The International Court of Justice's (ICJ) ruling in Nicaragua v. United States (1986) condemned economic coercion, but its symbolic nature and lack of enforcement highlight critical legal gaps⁵⁵. Robust mechanisms, such as mandatory Health Impact Assessments (HIAs) and UN oversight, are essential to address these violations and protect human dignity.

The sanctions disrupt access to healthcare, food, and adequate living standards, violating ICESCR obligations. In Iran, a 50% reduction in medicine imports left 6 million patients without essential drugs, breaching the right to health⁵⁶. In Venezuela, sanctions-driven food shortages pushed 7 million into hunger, undermining the right to food⁵⁷. The Russia's 17.8% inflation and Ukraine's 24.2% poverty surge eroded housing affordability, violating

⁴⁷. Food & Agric. Org., The State of Food Security and Nutrition in the World 2022 20 (2022), <https://www.fao.org/3/cc0639en/cc0639en.pdf>.

⁴⁸. Francisco Rodríguez, Sanctions and the Venezuelan Economy: Evidence from the Lancet 394 LANCET 1427, 1427 (2019).

⁴⁹. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II), June 8, 1977, 1125 U.N.T.S. 609, art. 14.

⁵⁰. U.N. Charter art. 41.

⁵¹. U.N. Dev. Programme, Human Development Report 2023/2024 50 (2024), <https://hdr.undp.org/content/human-development-report-2023-2024>.

⁵². UNICEF, Iran: Health Indicators 3 (2020), <https://data.unicef.org/country/irn/>.

⁵³. Philip Alston, Report of the Special Rapporteur on Extreme Poverty and Human Rights, U.N. Doc. A/HRC/35/26, at 5 (Apr. 28, 2017).

⁵⁴. International Covenant on Economic, Social and Cultural Rights, Dec. 16, 1966, 993 U.N.T.S. 3.

⁵⁵. Military and Paramilitary Activities in and against Nicaragua (Nicar. v. U.S.), 1986 I.C.J. 14 (June 27).

⁵⁶. Johan Galtung, Violence, Peace, and Peace Research, 6 J. PEACE RES. 167, 167 (1969).

⁵⁷. Ministry of External Affairs, Gov't of India, India's Position on Unilateral Sanctions 2 (2023), <https://www.mea.gov.in>.

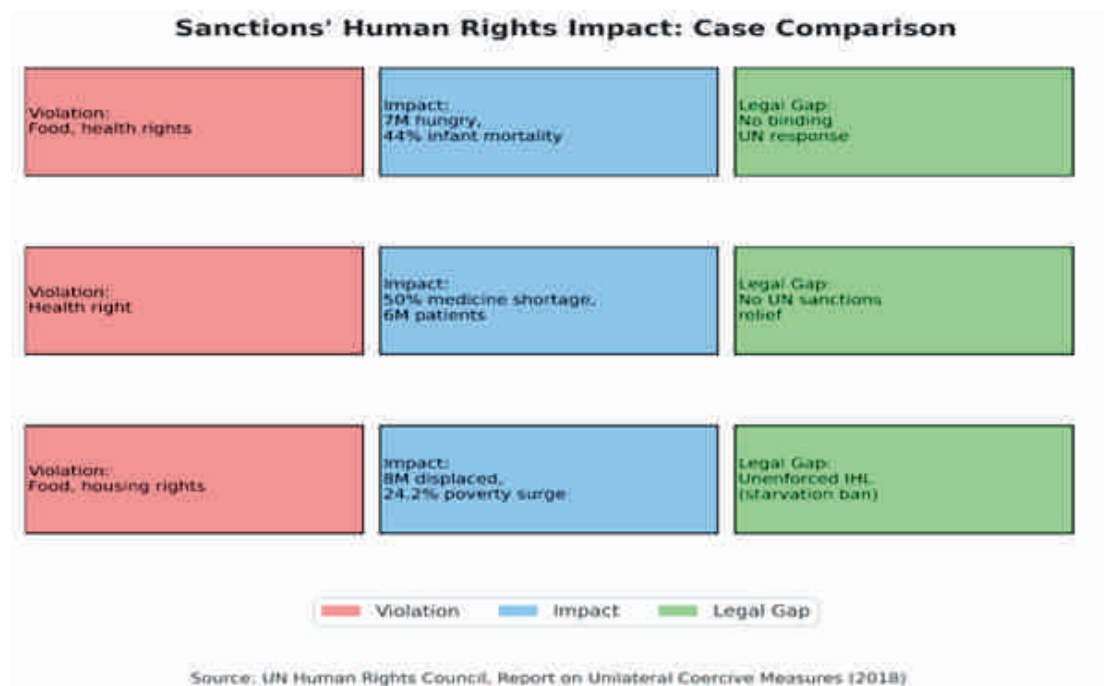
ICESCR's adequate living standards⁵⁸. These outcomes constitute structural violence, as defined by Johan Galtung, where systemic economic pressures deliberately harm civilians, particularly the poor, elderly, and children, who lack resilience against such crises⁵⁹.

IHL's prohibition of starvation (Geneva Protocol II, Article 14) is clear, yet sanctions evade this framework by operating indirectly. The ICJ's Nicaragua ruling declared economic coercion a violation of state sovereignty, but its

non-binding status limits enforcement. The UN Security Council's failure to regulate unilateral sanctions, as seen in U.S. actions against Iran and Venezuela, exacerbates this gap. Legal loopholes such as vague humanitarian exemptions and over-compliance by private firms enable sanctions to bypass accountability, despite UN calls for reform (UNHCHR, 2018). Robust mechanisms, like a UN oversight body to enforce proportionality and HIAs to monitor civilian impacts, are urgently needed to align economic warfare with IHL and ICESCR obligations.

Table 3: Human Rights Violations by Sanction Type

Sanction Type	ICESCR Right Violated	Impact Example	Case Study
SWIFT Exclusion	Health	Medicine shortages (6M affected)	Iran
Energy Export Bans	Food	Wheat shortages (20M at risk)	Russia-Ukraine
Asset Freezes	Housing	Poverty surge (24.2%)	Ukraine
Oil Sanctions	Food, Health	Hunger (7M), infant mortality rise	Venezuela



Legal frameworks and their limitations

International Humanitarian Law (IHL), rooted in the Geneva Conventions, regulates warfare, with Article 14 of

Protocol II (1977) prohibiting starvation as a method of warfare⁶⁰. Yet, economic sanctions, as seen in Russia-Ukraine (8M displaced), Iran (50% medicine shortages),

⁵⁸. Council of the European Union, Guidelines on Humanitarian Exemptions in Sanctions Regimes 5 (2023), <https://www.consilium.europa.eu/en/documents-publications/public-register>.

⁵⁹. World Food Programme, Yemen Food Security Update 1 (2023), <https://www.wfp.org/countries/yemen>.

⁶⁰. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II), June 8, 1977, 1125 U.N.T.S. 609, art. 14.

and Venezuela (7M hungry), evade these protections, causing systemic civilian harm⁶¹. UN Security Council (UNSC) Resolutions under Chapter VII authorize sanctions but lack mechanisms to assess civilian impacts, while unilateral sanctions, like U.S. measures on Iran, operate outside UN oversight⁶². The ICJ's Nicaragua v. United States (1986) ruling condemned economic coercion, but its non-binding nature limits enforcement⁶³. India, through the Geneva Conventions Act (1960) and UN (Security Council) Act (1947), complies with UN sanctions but opposes unilateral ones, maintaining trade with Iran via rupee-rial mechanisms to mitigate U.S. sanctions' humanitarian toll (MEA, 2023).

Enforcement gaps persist globally. IHL addresses direct violence, not indirect harms like sanctions-induced hunger

or health crises, which bypass starvation bans. The EU's 2023 humanitarian exemption guidelines aim to clarify trade for food and medicine, but compliance remains inconsistent (EU, 2023). India's advocacy for multilateral sanctions at the UN reflects its push for accountability, yet geopolitical divides stall reforms. Challenges include defining economic coercion as warfare, quantifying civilian harm, and reconciling state sovereignty with human rights. Without binding mechanisms like a UN oversight body or amended IHL protocols these gaps perpetuate structural violence, disproportionately affecting vulnerable populations. Robust frameworks, integrating India's multilateral stance and global calls for proportionality, are critical to address economic warfare's silent devastation.

Legal Frameworks: Strengths vs. Gaps

Framework	Strength	Legal Gap
Geneva Conventions	Prohibits starvation as a method of warfare (Article 14, Protocol II)	Lacks provisions addressing indirect economic harms resulting from sanctions
UN Security Council Resolutions	Authorizes sanctions under Chapter VII of the UN Charter	No dedicated mechanism for civilian impact oversight; humanitarian consequences often overlooked
ICJ Nicaragua Ruling	Condemned coercive actions violating sovereignty and non-intervention principles	Enforcement is limited; judgments are non-binding without Security Council backing
Indian Framework	Advocates for multilateral compliance and global justice	Limited global influence; challenges in shaping international legal norms

UN Human Rights Council's Report on Unilateral Coercive Measures (2018)

Policy gaps and proposed reforms for economic sanctions

I. Identified Policy Gaps

• Absence in the Geneva Conventions (1949)

- o These focus primarily on armed conflict and physical violence, lacking explicit reference to economic coercion⁶⁴.
- o Economic sanctions, despite their civilian impact, are not classified under International Humanitarian Law (IHL)⁶⁵.

- o Example: Sanctions on Venezuela led to shortages in essential goods without triggering IHL protection mechanisms⁶⁶.

• Ineffective Application of Humanitarian Exemptions

- o Though many sanctions include exemptions for food and medicine, they are often delayed or blocked⁶⁷.
- o Over-compliance by financial institutions, due to fear of violating sanction rules, obstructs

⁶¹. UNHCR, Ukraine Situation, <https://reporting.unhcr.org/operational/situations/ukraine-situation> (last visited May 17, 2025); Human Rights Watch, Maximum Pressure: U.S. Economic Sanctions Harm Iranians' Right to Health 1 (Oct. 29, 2019), <https://www.hrw.org/report/2019/10/29/maximum-pressure/us-economic-sanctions-harm-iranians-right-health>; Food & Agric. Org., The State of Food Security and Nutrition in the World 2022 20 (2022), <https://www.fao.org/3/cc0639en/cc0639en.pdf>.

⁶². U.N. Charter art. 41.

⁶³. Military and Paramilitary Activities in and against Nicaragua (Nicar. v. U.S.), 1986 I.C.J. 14 (June 27).

⁶⁴. Gordon, J. (2019), Invisible war: The United States and the Iraq sanctions, Harvard University Press.

⁶⁵. Mulder, N. (2022), The economic weapon: The rise of sanctions as a tool of modern war, Yale University Press.

⁶⁶. Weisbrot, M., & Sachs, J. (2019), Economic sanctions as collective punishment: The case of Venezuela. Center for Economic and Policy Research. <https://cepr.net/report/economic-sanctions-as-collective-punishment-the-case-of-venezuela/>

⁶⁷. Human Rights Watch. (2020), Targeted sanctions and human rights: The need for humanitarian safeguards. <https://www.hrw.org/news/2020/10/29/targeted-sanctions-and-human-rights>.

- humanitarian aid⁶⁸.
 - Case in point: In Yemen, 17 million people were food insecure in 2023 despite stated exemptions⁶⁹.
 - **Lack of Oversight or Accountability Mechanism**
 - No international regulatory body exists to evaluate the humanitarian impact or proportionality of sanctions⁷⁰.
 - Many unilateral sanctions bypass UN Security Council scrutiny⁷¹.
 - Consequence: Measures designed for political leverage disproportionately affect vulnerable populations⁷².
 - Require that sanctions include time-bound and enforceable exemptions for essential goods and services⁷³.
 - Example: Financial institutions could be obligated to process humanitarian transactions within 48-72 hours under UNSC supervision⁷⁴.
 - **Establish a UN Sanctions Oversight Body**
 - An independent, expert-led panel should monitor the real-time impact of sanctions using measurable indicators (e.g., mortality rates, access to healthcare, food security)⁷⁵.
 - This body would issue public reports and recommend revisions or suspensions when humanitarian thresholds are breached⁷⁶.
 - **Adopt a Unified Global Sanctions Policy**

Introduce a comprehensive framework that:

 - Encourages targeted sanctions over blanket embargoes⁷⁷.
 - Outlaws politically motivated sanctions aimed at regime change or economic collapse⁷⁸.
 - Upholds the right to life and dignity under global human rights instruments (e.g., ICESCR, UDHR)⁷⁹.
- II. Proposed Reforms**
- **Classify Indiscriminate Sanctions as War Crimes**
 - Amend the Geneva Conventions to treat sanctions that foreseeably cause mass civilian harm as prosecutable offenses⁸⁰.
 - Aligns with the principle that indiscriminate attacks whether physical or economic should be prohibited⁸¹.
 - **Mandate Humanitarian Carve-Outs with Enforceability**

III. Summary Table: Proposed Sanction Regulation Framework

Component	Proposed Reform
War Crimes Classification	Amend Geneva Conventions to criminalize indiscriminate sanctions
Humanitarian Carve-Outs	Legally binding, time-bound exemptions for essentials, enforced by UNSC
UN Oversight Body	Independent monitoring and reporting on humanitarian impact
Unified Global Policy	Establish legal standards ensuring proportionality, necessity, and rights-compliance

⁶⁸. Peksen, D. (2019), When do economic sanctions work? A critical review of the literature, *Defence and Peace Economics*, 30 (6), 635-647, <https://doi.org/10.1080/10242694.2019.1625250>.

⁶⁹. United Nations Office for the Coordination of Humanitarian Affairs. (2023), Yemen humanitarian needs overview 2023. <https://www.unocha.org/publications/report/yemen/yemen-humanitarian-needs-overview-2023> ; World Food Programme. (2023), Yemen: Food security and nutrition assessment. <https://www.wfp.org/countries/yemen>.

⁷⁰. Supra note 65.

⁷¹. Felbermayr, G., Kirilakha, A., Syropoulos, C., Yalcin, E., & Yotov, Y. V. (2020), The global sanctions data base: An application to the Russia sanctions, *European Economic Review*, 129, 103561. <https://doi.org/10.1016/j.euroecorev.2020.103561>.

⁷². Supra note 67.

⁷³. Supra note 64.

⁷⁴. Supra note 65.

⁷⁵. United Nations. (2022), Security Council Resolution 2664 (2022), on humanitarian exemptions to sanctions. [https://undocs.org/S/RES/2664\(2022\)](https://undocs.org/S/RES/2664(2022)).

⁷⁶. Supra note 67.

⁷⁷. Supra note 68.

⁷⁸. Supra note 75.

⁷⁹. Supra note 71.

⁸⁰. Supra note 65.

⁸¹. Supra note 67.

III. Summary Table: Proposed Sanction Regulation Framework

Conclusion

The evidence gathered in this paper confirms that modern economic sanctions inflict grave harm on civilians, amounting to structural violence in peacetime. Case studies from Ukraine, Iran, and Venezuela show how broad trade embargoes devastate ordinary lives by causing food shortages, medical crises, and economic collapse. For example, U.S. sanctions on Iran have "drastically constrained" the country's ability to import essential medicines and other humanitarian goods, causing "serious hardships for ordinary Iranians"⁸². Likewise, experts warn that Venezuela's sanctions have increased "disease and mortality" and worsened "widespread hunger" among the population⁸³. In each case, innocent people bear the brunt of measures aimed at their governments.

These findings reinforce the argument that sanctions are effectively a form of modern warfare. Sanctions deliberately weaponize civilian suffering to pressure governments, violating core humanitarian principles. As one analysis notes, even supposedly "smart" sanctions still "produce enormous harm to civilian populations" under legal regimes with "scant humanitarian guardrails"⁸⁴. In practice, entire societies can feel besieged by economic coercion: starvation, disease and deprivation become means to an end - a tactic of collective punishment⁸⁵. This silent siege accepts no distinction between combatant and civilian, abandoning the very rules (distinction, proportionality) that bind lawful warfare⁸⁶.

This moral and legal crisis demands urgent reform. International law must catch up to these indirect forms of violence. We echo calls to amend the Geneva Conventions and related treaties to explicitly cover economic blockades, and to mandate enforceable humanitarian exemptions in every sanction's regime⁸⁷. In fact, recent developments point the way. For example, UN Security Council Resolution 2664 (2022) explicitly

excludes humanitarian action - including food, medicine and other life-saving aid - from UN sanctions, recognizing that such aid must be protected even in conflict⁸⁸. However, this remains only a partial fix. Without binding international standards, states can still impose crippling embargoes without accountability. A unified global framework is needed so that every sanction regime automatically carves out essential goods and is subject to empowered UN oversight⁸⁹.

The imperative is immediate and moral: human dignity must override geopolitical power plays. International law and ethics rest on the premise that every person has intrinsic worth that no conflict can nullify. To ignore the civilian toll of economic sieges is to abandon that foundational commitment. In the final analysis, we are reminded of Thomas Jefferson's maxim: The care of human life and happiness, and not their destruction, is the first and only legitimate object of good government⁹⁰. This dictum encapsulates the moral truth at stake - policies must be judged by whether they protect people, not punish them.

Economic sanctions, often wielded as instruments of geopolitical strategy, have emerged as a silent killer, inflicting profound suffering on civilian populations under the guise of non-violent coercion. This analysis reveals how the Geneva Conventions' silence on economic warfare, coupled with ineffective humanitarian exemptions and the absence of global oversight, enables sanctions to devastate lives without accountability⁹¹. The silent brutality of economic warfare starving communities, denying medical care, and collapsing economies demands urgent legal and policy recognition. Human rights are paramount; no pursuit of revenge or political leverage justifies stripping civilians of their fundamental rights to food, medicine, and dignity. Immediate reforms are critical. Amending the Geneva Conventions to classify indiscriminate sanctions as war crimes, mandating enforceable humanitarian carve-outs, establishing a UN oversight body, and formulating a unified global policy are essential steps to curb this covert violence. These measures

⁸². Ibid.

⁸³. Weisbrot, M., & Sachs, J. (2019), Economic sanctions as collective punishment: The case of Venezuela. Center for Economic and Policy Research. <https://cepr.net/report/economic-sanctions-as-collective-punishment-the-case-of-venezuela/>

⁸⁴. Mulder, N. (2022), The economic weapon: The rise of sanctions as a tool of modern war, Yale University Press.

⁸⁵. Peksen, D. (2019), When do economic sanctions work? A critical review of the literature, *Defence and Peace Economics*, 30 (6), 635-647, <https://doi.org/10.1080/10242694.2019.1625250>.

⁸⁶. Gordon, J. (2019), *Invisible war: The United States and the Iraq sanctions*, Harvard University Press.

⁸⁷. Ibid.

⁸⁸. United Nations. (2022), Security Council Resolution 2664 (2022), on humanitarian exemptions to sanctions. [https://undocs.org/S/RES/2664\(2022\)](https://undocs.org/S/RES/2664(2022)).

⁸⁹. Felbermayr, G., Kirilakha, A., Syropoulos, C., Yalcin, E., & Yotov, Y. V. (2020), The global sanctions data base: An application to the Russia sanctions, *European Economic Review*, 129, 103561. <https://doi.org/10.1016/j.euroecorev.2020.103561>.

⁹⁰. Peksen, D. (2019), When do economic sanctions work? A critical review of the literature, *Defence and Peace Economics*, 30 (6), 635-647, <https://doi.org/10.1080/10242694.2019.1625250>.

⁹¹. Mulder, N. (2022), *The economic weapon: The rise of sanctions as a tool of modern war*, Yale University Press.

would ensure sanctions target aggressors, not innocents, preserving human dignity amidst geopolitical conflicts. Looking forward, research must explore how to balance state sovereignty with humanitarian protections, addressing the tension between national interests and global ethical obligations. This work is vital to prevent economic measures from becoming tools of collective punishment.

The international community must act swiftly to reform sanctions regimes, reaffirming that civilian suffering is

never an acceptable byproduct of economic warfare. By prioritizing human rights and implementing robust regulations, we can foster global peace and uphold the principles of justice and humanity that underpin international law. This is not merely a legal imperative but a moral one, calling for collective action to protect the vulnerable and ensure a world where human dignity prevails.

Cyber Attacks against the Healthcare Sector and the Use of Force under International Law

Ms. Jyoti Singh*

ABSTRACT

The frequency and intensity of cyberattacks on the healthcare sector have grown recently. There have been cases of ransomware and data breaches that have rendered hospital systems utterly unusable and present serious risks to public safety and national security. The threat or use of force is forbidden by Article 2(4) of the Charter, which also exhorts all Members to respect the political independence, territorial integrity, and sovereignty of other States. This essay will try to investigate the application of international law and the use of force to cyberattacks against the healthcare industry. Generally speaking, states using military troops to conduct physical attacks are considered to be using force under the UN Charter. However, with the development of technology, it is now evident that cyberattacks can cause enormous harm, affect medical care and life-saving equipment, and even result in fatalities. The purpose of this article is to examine the circumstances under which a cyberattack might be considered as "an armed attack" or even a "use of force", so as to enable the states to exercise their right to self-defense under Article 51 UN Charter. However, applying these legal precepts to cyberattacks is a very challenging task, because of things like attribution, intent, and the non-physical nature of cyberattacks. Since cyberattacks are not governed by any international convention, it becomes more challenging to apply international law to them. However, an attempt has been made to utilize contemporary examples of cyberattacks during the COVID-19 pandemic in it. Even though they are not legally binding, legal publications like the Tallinn Manuals provide important information on how states and legal experts view the guidelines for conduct in cyberspace. The paper will conclude by arguing for the development of clearer international norms and mechanisms to protect the healthcare sector from cyber harm.

Keywords: Cyberattacks, UN Charter, Tallinn Manual, Self defence, Use of Force

I. Introduction

Over a period of time, because of the ever increased advent of digital technologies into every sector including the healthcare industry, there has been a major improvement in the quality, effectiveness, and accessibility of the industry. At the same time, a number of new challenges have been brought about by this digital revolution, with cyberattacks on the hospitals working system being the most prominent one¹. The malicious cyber activities, which includes ransom ware and data breaches have started targeting the hospitals, research

centers, pharmaceutical companies, and health insurance companies more frequently². Any cyberattack on the healthcare facilities can affect lives, interrupt vital services, and wear away the trust of public and therefore stakes are extremely high. Article 2(4) of the UN Charter seeks to ascertain, whether or not, the cyberattacks on healthcare services can be categorized as "use of force"³. It also seeks to ascertain availability of the right to self-defense to states to counter this⁴. This paper attempts to explore the legal implications of cyberattacks on the healthcare sector, with an emphasis on use of force under international law.

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¹ Matsu Alawida, Abiodun Esther Omolara, Oludare Isaac Abiodun, Murad Al-Rajab, "A deeper look into cybersecurity issues in the wake of Covid-19: A survey", available at <https://www.sciencedirect.com/science/article/pii/S1319157822002762> (Last visited on 29/04/2015)

² Ibid

³ Matthew C. Waxman, Cyber Attacks as "Force" Under UN Charter Article 2(4), 87 INT'L L. STUD. 43 (2011). available at: https://scholarship.law.columbia.edu/faculty_scholarship/847 (Last visited on 29/04/2025)

⁴ Ibid

II. Cyber attacks on the healthcare industry

It is a fact that the healthcare sector has overall seen an incredible digital transformation in the last few years. The working of medical services has been drastically changed by the tools and techniques it has developed. In the meanwhile, this digital advancement has also resulted in plentiful shortcomings. Unfortunately, healthcare businesses typically rely on outdated software due to budgetary constraints and many hospital networks are composed of incompatible and insecure technology⁵. Additionally, latest updates and fool proof digital safety measures -which are crucial for cybersecurity-are usually ignored or delayed, leaving these systems open to misuse⁶. At the same time, many healthcare institutions lack professional cybersecurity teams, which exacerbate this vulnerability.

The healthcare sector is targeted for several key reasons⁷:

- a) **High-Value Data:** Medical records contain a wealth of sensitive information, including personal identification details, insurance information, and medical history. This data is more valuable than credit card information on the black market because it can be used for identity theft, insurance fraud, and blackmail.
- b) **Critical Services:** Hospitals and clinics provide life-saving services. This urgency makes them more likely to pay ransoms quickly during a ransomware attack to avoid disruptions that could cost lives.
- c) **Lower Cybersecurity Maturity:** Compared to sectors like finance or defense, healthcare institutions often lack advanced cybersecurity frameworks and personnel, making them easy targets.
- d) **Political and Strategic Motives:** During times of crisis-such as the COVID-19 pandemic-state and non-state actors have used cyber attacks to steal vaccine research, disrupt supply chains, or destabilize public trust in healthcare systems.

Real-World Examples:

- a) **Düsseldorf University Hospital (2020):** In one of

the most tragic examples, a ransomware attack on a hospital in Düsseldorf, Germany, caused system failures that delayed emergency treatment⁸. A patient requiring urgent care had to be transferred to another hospital over 20 miles away and later died. German authorities opened a negligent homicide investigation, marking one of the first known cases where a death was linked directly to a cyber attack.

- b) **COVID-19 Pandemic Attacks:** During the global health crisis, cyber attacks on hospitals and vaccine producers surged. The World Health Organization (WHO) and multiple vaccine developers reported phishing campaigns and intrusion attempts. These attacks threatened not just organizational operations, but global public health⁹.
- c) **HSE Ireland (2021):** The Health Service Executive (HSE) of Ireland was hit by a sophisticated ransomware attack that caused a nationwide shutdown of its IT systems¹⁰. Thousands of appointments and procedures were canceled. It took months to fully restore services, and the government labeled it the most significant cyber attack on the Irish state.

Because of a combination of systemic weaknesses, vital service delivery, and valuable data, the healthcare industry has emerged as a prominent target for cybercriminals. Such attacks can have far-reaching effects on national and international health security, put lives in danger, and damage public trust in addition to causing financial loss or operational interruption. Given this, it is essential to address these attacks in accordance with the relevant international regulatory frameworks in addition to bolstering cybersecurity in the healthcare industry. The distinction between criminal behavior and transgressions of international law, such the use of force, becomes hazy when cyberattacks cause physical harm or fatalities, necessitating strict legal examination and reaction.

III. The United Nations Charter and the Prohibition on the Use of Force:

The United Nations Charter, adopted in 1945, is the primary international legal instrument that governs the use

⁵. Healthcare Cybersecurity: Addressing Vulnerabilities In The Medical Industry, available at <https://www.cogentinfo.com/resources/healthcare-cybersecurity-addressing-vulnerabilities-in-the-medical-industry> (Last visited on 30/04/2025)

⁶. Ibid

⁷. 7 Reasons Why Healthcare is the Biggest Target for Cyberattacks, available at <https://asimily.com/blog/why-healthcare-is-prime-target-for-cyberattacks/> (Last visited on 30/04/2025)

⁸. Steve Alder, "Hospital Ransomware Attack Results in Patient Death", available at <https://www.hipaajournal.com/hospital-ransomware-attack-results-in-patient-death/> (Last visited on 30/04/2025)

⁹. Beware of criminals pretending to be WHO, available at <https://www.who.int/about/cybersecurity> (Last visited on 01/05/2025)

¹⁰. Padraic Halpin and Conor Humphries, 'Irish health service hit by 'very sophisticated' ransomware attack' available at <https://www.reuters.com/technology/irish-health-service-hit-by-ransomware-attack-vaccine-rollout-unaffected-2021-05-14/> (Last visited on 01/05/2025)

of force between the states¹¹. The purpose of the UN Charter is to maintain international peace and security by prohibiting the unilateral use of force between states. Article 2(4) of the UN Charter reads that "All Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state or in any other manner inconsistent with the Purposes of the United Nations"¹². This article of the UN establishes a blanket prohibition on the use of force in international relations. Conventionally, this applies to kinetic military actions, which includes, invasions, bombardments and blockades-but the rise of cyber operations has challenged these conventional ways¹³. The UN Charter does not define "force" or "armed attack," which leaves space for interpretation¹⁴. The question that arises today is whether and under what conditions a cyberattack, such as a ransomware attack on a hospital or the incapacitation of the critical medical infrastructure, may amount to a "use of force" under Article 2(4)¹⁵.

3.1 Definition of "Force" vis-à-vis Cyberattack:

There is no consensus on the definition of "force" in international law, other than the fact that it refers to coercion by an armed or military brigade¹⁶. Many cyber acts, even though, being non-kinetic, may still have destructive effects, which can be on par with those brought on by physical force. There are several ways that academics have suggested to define "force" in the context of cyberspace:

- a) **Instrument based:** This approach is based on the means of cyber attacks. This, according to critics, is overly limiting because cyber weapons are very different from conventional military equipment.
- b) **Target-based:** This takes into account the intended target's characteristics (e.g., military vs. civilian). Nevertheless, this is unclear because many cyberattacks target dual-use systems, such hospital IT networks.

- c) **Effects-based:** The most popular method, which is backed by the Tallinn Manual, takes the act's effects into account. A cyber operation may be considered a use of force if it results in outcomes similar to a kinetic attack, such as devastation, fatalities, or incapacitation.

Therefore, under Article 2(4), a cyberattack that interferes with a nation's electrical infrastructure, stops military communications, or results in fatalities due to hospital system malfunctions may be considered a forbidden force.

3.2 Customary International Law and State Practice:

It has been acknowledged by the United States that there are some cyberattacks that may amount to a use of force in its Department of Defense Law of War Manual¹⁷. On the other hand, Netherlands recognized noticeably that if a cyberattack had effects which are similar to those of traditional kinetic force, it might qualify as a use of force¹⁸. France also accepted that cyberattacks that cause bodily harm or if they result in death, then they might be considered as armed attacks¹⁹. However, there still is disagreement between the states about where the line should be established irrespective of these advanced projections²⁰. The way authorities may react to cyberattacks, particularly ones that target vital civilian infrastructure like healthcare, is significantly impacted by this legal ambiguity.

IV. Threshold for use of force and the cyberattacks on the health care sector

It is always a cumbersome task to find out about a cyber operation, qualifying as a "use of force" under international law as the digital and physical worlds are too intertwined. It is very difficult to establish anything related to use of force, when it comes to healthcare industry, which is inextricably related to human life and dignity and is one the most sensitive working area. Though, the use of force against a state's political independence or territorial integrity is outlawed by international law (as stated in Article 2(4) of the UN Charter), however, it is uncertain as to how this rule

¹¹. Michael Wood, 'International Law and the use of force: What happens in Practice?' available at https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://legal.un.org/avl/pdf/ls/wood_article.pdf&ved=2ahUKewjc0qb5jKaNaXUNs1YBH4WHB4AQFnoECClQAQ&usq=AOvVaw1smMhdhb8dn3BsqUYDB054 (Last visited on 05/05/2024)

¹². Ibid

¹³. Supra note 3 at 47

¹⁴. Ibid

¹⁵. Samuli Haataja, Cyber operations against critical infrastructure under norms of responsible state behaviour and international law, *International Journal of Law and Information Technology*, Volume 30, Issue 4, Winter 2022, Pages 423-443

¹⁶. Christian Schaller, 'When aid or assistance in the use of force turns into an indirect use of force', 10(2) *Journal on the Use of Force and International Law*, 173-200

¹⁷. 'Use of Force in Cyberspace', available at <https://www.congress.gov/crs-product/IF11995> (Last visited on 15/05/2025)

¹⁸. 'Use of force', available at https://cyberlaw.ccdcoe.org/wiki/Use_of_force#:~:text=A%20cyber%20operation%20that%20targets%20critical%20infrastructure%20and%20results%20in,example%20of%20use%20of%20force.%22 (Last visited on 15/05/2025)

¹⁹. Ibid

²⁰. Ibid

applies to cyberattacks, especially those that target medical infrastructure²¹. Under this sub-section, the focus will be the cyberattacks targeting the healthcare industry and if they could escalate into what is known as the "use of force" under international law.

4.1 Reassessing the use of force vis-à-vis cyberattacks:

Cyber operations frequently leave no tangible evidence, in contrast to kinetic strikes. However, the repercussions can be equally disastrous. One of the most reputable scholarly works on the topic, the Tallinn Manual 2.0, suggests evaluating cyber operations based on their results rather than their methodology²². This leads to the following important criteria²³:

a) Physical impairment:

The idea of bodily hurt or physical damage is central to the use-of-force threshold²⁴. There could be direct fatalities from a cyberattack that turns off hospital ventilators, deletes important patient data, or postpones urgent surgeries²⁵. Even if it is indirect, the link between digital infiltration and bodily consequences can be fatal. For example, the attack's result is functionally equal to planting a bomb on a hospital if ransomware paralyzes its systems, prohibiting surgeries or real-time care, and a patient dies as a result. Even when the digital weapon takes a different shape, the pain it creates is just as great.

b) The extent and severity of the disturbance:

Beyond individual injuries, the magnitude of the disturbance is important. In the event of a public health emergency, a cyber campaign that renders many hospitals nationwide inoperable may constitute systemic sabotage. The public's trust in vital institutions might be damaged, national stability could be jeopardized, and government response to crises could be diminished. At this degree of intensity, a cyber operation starts to have the substance and impact of an act of force.

c) Nature and purpose of the attack:

An important consideration in a legal assessment of a cyberattack is the attacker's identity and intent²⁶. State-perpetrated or state-attributed cyberattacks are more likely to be construed as uses of force, especially if they are hostile or coercive in nature. Their legal and moral seriousness increases when such actions are intentionally targeted at the general public or vital civilian services like hospitals. Furthermore, there is a stronger case for classifying the attack as a prohibited use of force if it takes place during an ongoing geopolitical confrontation or as part of a larger campaign of intimidation or instability²⁷.

4.2 Cases off cyberattack on healthcare sector:

1. WannaCry and the UK's National Health Service (2017)²⁸:

More than 150 nations were affected by the WannaCry ransomware assault in May 2017 and one of the most badly impacted was the National Health Service (NHS) in the United Kingdom. It led to the cancellation of thousands of appointments and procedures as the malware affected the diagnostic services and also affected the encryption of vital systems. Patients were removed from emergency rooms, and ambulances were rerouted. Even while WannaCry was not directly responsible for any deaths, it had a huge indirect impact on the medical system. Although its impact was primarily pecuniary rather than coercive or strategic one, it showed that how a cyberattack might easily paralyze a country's health system.

2. The Düsseldorf Hospital Incident (2020)²⁹:

In September 2020, a ransomware attack on the University Hospital Düsseldorf's IT systems in Germany had a very serious impact. There were deadly delays in the transfer of critically ill patients to another facility. This is apparently regarded as one of the first acknowledged death in public, that was indirectly caused by a cyberattack on healthcare facilities. Legally speaking, this occurrence shows that an act can be disastrous even when intent and result do not

²¹. Steven R. Ratner, 'Norms of Territorial Integrity and Political Independence: The Ban on the Use of Force and Non-Intervention', *The Thin Justice of International Law: A Moral Reckoning of the Law of Nations* (Oxford, 2015; online edn, Oxford Academic, 20 Aug. 2015), available at <https://doi.org/10.1093/acprof:oso/9780198704041.003.0005> (Last visited on 16/0/2025)

²². Ferry Oorsprong, P.A.L. Ducheine, and Peter Pijpers, 'Armed Attack in Cyberspace: Clarifying and Assessing When Cyber-Attacks Trigger the Netherlands' Right of Self-Defence', available at <https://ssrn.com/abstract=3934417> or <http://dx.doi.org/10.2139/ssrn.3934417> (Last visited on 16/0/2025)

²³. Ibid

²⁴. E. Pobjie 'Elements of 'Use of Force': Effects, Gravity and Intention. In: *Prohibited Force: The Meaning of 'Use of Force' in International Law*, (Cambridge University Press; 2024:132-158)

²⁵. Benyamine Abbou, 'When all computers shut down: the clinical impact of a major cyber-attack on a general hospital', available at <https://pmc.ncbi.nlm.nih.gov/articles/PMC10904636/> (Last visited on 16/05/2025)

²⁶. E. Tikk, K. Kaska and L. Vihul, 'International cyber incidents; legal considerations', available at https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://ccdcoe.org/uploads/2018/10/legalconsiderations_0.pdf (Last visited on 17/05/2025)

²⁷. Supra note 24

²⁸. What was the WannaCry ransomware attack?, available at <https://www.cloudflare.com/learning/security/ransomware/wannacry-ransomware/> (Last visited on 17/05/2025)

²⁹. Supra note 8

exactly match up. It can be said, therefore, that the foreseeability of injury may be sufficient to warrant a use-of-force inquiry, even in the absence of a specific intent to kill.

3. The COVID-19 Pandemic and Cyber Espionage³⁰:

Cyberattacks against public health organizations, pharmaceutical corporations, and vaccine developers increased during the COVID-19 pandemic. Although the majority of these activities were classified as cyber espionage since they sought data rather than destruction, their possible outcomes were concerning. Such attacks would have caused widespread injury and possibly prompted international legal remedies if they had interfered with the distribution of vaccines or public health communication networks.

V. Understanding the Legal Boundaries: Armed Attack or Use of Force?

Pertinently, it is very significant to differentiate between an armed attack under Article 51, which would allow a state to use force in self-defense, and a prohibited use of force under Article 2(4) of the UN Charter, under international law³¹. While a wide range of coercive measures are included in the definition of "use of force," military retaliation to use of force is not justified. On the other hand, an armed attack is a subset of force use that results in extremely serious harm, usually death or extensive destruction³². One could argue that a cyberattack on a hospital qualifies as an armed attack when it results in numerous fatalities or disrupts healthcare in an area. Legal experts warn against automatic escalation, nevertheless. The focus is still on proportionality, necessity, and unambiguous attribution-criteria that are predominantly difficult to meet in the online space³³.

All things considered, it may be said that the cyberattacks on healthcare systems can qualify as a use of force, especially if they cause fatalities, extensive disruptions, or the permanent denial of vital services. Targeting hospitals, medical equipment, and life-saving technologies cannot

be viewed as just inconvenient or spying, according to developing jurisprudence, even though international law is still cautious and context-sensitive when making such judgments. Rather, these actions undermine the fundamental humanitarian principles protected by international law as well as the functional integrity of national healthcare systems³⁴. In a world where war can now be fought without a single shot being fired, it is very obligatory to clear the current ambiguity in legal interpretation involved in cyberattack on healthcare sector.

VI. Difficulties in applying International Law to Cyberattacks:

Although the UN Charter, customary international law, and the laws of armed conflict provide a comprehensive legal framework for controlling the use of force between states, there are still questions left answered, about the applicability of these principles to cyber operations³⁵. In contrast to traditional warfare, cyber combat presents new difficulties that put existing legal theories to the test and reveal significant normative and practical flaws in the current legal system. The main operational and legal obstacles to applying international law to cyberattacks are examined in this section, particularly as they relate to the healthcare industry. These include issues with attribution, the lack of enforceable standards unique to cyberspace, the issue of dual-use infrastructure, and the fracturing of legal consensus.

6.1 Attribution:

Attribution, or identifying the perpetrator of an attack, is arguably the most difficult task in the legal regulation of cyber activities. Attribution is frequently instantaneous and obvious in conventional military conflicts: a missile's launch location can be tracked, and an invading army may be recognized by its uniforms and flags³⁶. However, things are very different in online. Layers of mystification are frequently used in cyber operations, such as, misattributed code fragments, proxy servers, botnets, and spoof IP addresses, which all deceive investigators³⁷. In order to provide reasonable deniability and to make legal

³⁰. Supra note 9

³¹. Adil Ahmad Haque, 'The United Nations Charter at 75: Between Force and Self-Defense - Part One', available at <https://www.justsecurity.org/70985/the-united-nations-charter-at-75-between-force-and-self-defense-part-one/> (Last visited on 18/05/2025)

³². Ibid

³³. CDR Peter Pascucci, "Distinction and Proportionality in Cyber War: Virtual Problems with a Real Solution" (2017). Minnesota Journal of International Law. 257, available at <https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://scholarship.law.umn.edu/cgi/viewcontent.cgi?article%3D1256%26context%3Dmjlil> (Last visited on 18/05/2025)

³⁴. International Laws Protecting Civilians in Armed Conflict Not Being Upheld, Secretary-General Warns Security Council, Urging Deadly Cycle Be Broken, available at <https://press.un.org/en/2023/sc15292.doc.htm> (Last visited on 18/05/2025)

³⁵. Tom Ruys, The Meaning of "Force" and the Boundaries of the Jus ad Bellum: Are "minimal" Uses of Force Excluded from UN Charter Article 2(4)?, The American Journal of International Law Vol. 108, No. 2 (Cambridge University Press, 2014, 159-210)

³⁶. Paulina Starski, Right to Self-Defense, Attribution and the Non-State Actor - Birth of the "Unable or Unwilling" Standard?, available at https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.zaoerv.de/75_2015/75_2015_3_a_455_502.pdf (Last visited on 19/05/2025)

³⁷. Ibid

countermeasures extra difficult, nation-states usually use outside actors, like criminal organizations or freelance hackers, to carry out attacks on their behalf.

A victim state cannot claim with confidence that another state has attacked it or use legal remedies like self-defense under Article 51 of the UN Charter if there is uncertain and untrustworthy attribution³⁸. In addition to increasing the likelihood of illegal reprisal, the risk of misattribution also raises tensions due to erroneous assumptions. States are frequently reluctant to publicly recognize assaults unless the proof is overwhelming, even when technical information suggests the involvement of a likely perpetrator³⁹. This is because they have apprehension about diplomatic ramifications, damage to reputation, or an escalating twist. Consequently, the evidentiary requirement for attribution in international law is still up for debate, and state practice continues to be inconsistent.

6.2 Disjointed legal interpretations and lack of consensus:

Another obstacle in applying international law to cyberattacks is the absence of an international agreement on how the current legal standards relate to cyber activities. Although the UN Group of Governmental Experts (GGE) and the Open-Ended Working Group (OEWG) have reinforced the general consensus that international law applies to cyberspace, there is still much disagreement about the specifics⁴⁰. This disagreement has halted the development of global standards and produced legal ambiguities that bad actors can take advantage of. States may differ on a number of issues, including the legality of countermeasures, the role of consent in international cyber activity, the threshold for self-defense, and whether a cyber operation qualifies as a use of force⁴¹. Lack of a legally binding international instrument specifically pertaining to cyber operations means that enforcement is lax, interpretation is arbitrary, and behavior is mostly controlled by unilateral doctrines or informal standards, many of which are opaque and unaccountable.

6.3 Blurred Lines of the Military and Civilians establishments:

Dual-use infrastructure, or buildings and technologies that is generally used for both military and civilian objectives, is frequently illustrated by the healthcare industry⁴². A hospital may be part of a larger military command system, act as an emergency response center, or treat soldiers during armed conflict. The legal status of such targets in cyberspace is complicated by their dual-use nature. According to international humanitarian law (IHL), civilian objects are no longer protected if they are effectively employed to support military action and their destruction gives the military a clear tactical advantage⁴³. For example, would an attack be justified if an enemy took down a hospital's diagnostic or scheduling systems in order to interfere with military logistics? What if the disturbance takes the lives of civilians or prevents vulnerable people from receiving care?⁴⁴ Legally and morally, these issues are still up for debate, underscoring the need for more context-sensitive interpretations and robust normative safeguards for online healthcare.

There is still uncertainty, caution, and legal inertia around the application of international law to cyber activities. Although fundamental ideas like sovereignty, non-intervention, and the ban on using force are still important, attribution issues, interpretive fragmentation, and technical complexity frequently make them less useful. The healthcare industry serves as an example of the necessity of doctrinal evolution because it is a crucial and sensitive subject. Cyberattacks on medical infrastructure will keep pushing the limits of the law-and the ability of the systems that preserve human life and dignity in both times of peace and conflict-in the absence of explicit legal protections, enforceable standards, and collaborative frameworks⁴⁵.

VII. State Responsibility:

Due to operational complexity and legal uncertainty, applying international law to cyberattacks-especially those that target the healthcare industry-presents significant

³⁸. Nidaa Iqbal, 'Lawfully Exercising the Right to Self-defence under Article 51 of the UN Charter to Recover Occupied Territory', available at <https://www.dlpforum.org/2023/04/15/lawfully-exercising-the-right-to-self-defence-under-article-51-of-the-un-charter-to-recover-occupied-territory/> (Last visited on 19/05/2025)

³⁹. Ibid

⁴⁰. M.M. Rahman, T.K. Das, 'Countering Cyberattacks: Gaps in International Law and Prospects for Overcoming them', available at <https://doi.org/10.21202/jdl.2024.46> (Last visited on 19/05/2025)

⁴¹. Ibid

⁴². Oona A. Hathaway, Azmat Khan and Mara Redlich Revkin, 'The Dangerous Rise of Dual-Use Objects in War', available at SSRN: <https://ssrn.com/abstract=4938707> or <http://dx.doi.org/10.2139/ssrn.4938707> (Last visited on 19/05/2025)

⁴³. Luigi Daniele, 'Incidental harm of the civilian in international humanitarian law and its Contra Legem antonyms in recent discourses on the laws of war', 29 *Journal of Conflict and Security Law* (Spring 2024), Pages 21-54

⁴⁴. Ibid

⁴⁵. 'Cyberattacks on healthcare: A global threat that can't be ignored', available at <https://news.un.org/en/story/2024/11/1156751> (Last visited on 20/05/2025)

⁴⁶. H. Moynihan, 'The vital role of international law in the framework for responsible state behaviour in cyberspace. 6 (3) *Journal of Cyber Policy*, 6(3), 394-410

challenges⁴⁶. The most noteworthy of them is the issue of attribution, as cyberspace is anonymous and misleading, making it very difficult to identify the perpetrator of an attack with the level of certainty, which is necessary to initiate legal remedies against another state under the UN Charter and other laws. Political hesitancy and a lack of proof frequently prevent formal attribution, even in cases where governments suspect hostile actors of involvement, restricting the use of collective action or countermeasures⁴⁷.

This is made worse by the lack of international agreement on how current legal norms-such as the meanings of "use of force" and "armed attack"-should be applied to cyber operations. The healthcare infrastructure's dual-use nature makes legal inquiry even more complicated as hospitals may have both military and civilian uses. Furthermore, because international courts have limited experience deciding cyber claims and because many states prefer quiet diplomacy or unilateral sanctions to formal legal systems, enforcement tools are still either nonexistent or very weak⁴⁸. It is also a fact that the law finds it difficult to keep up with technical advancements,

making healthcare systems more susceptible to cyberattacks during times of peace and war. This emphasizes the urgent need for more precise legal guidelines, collaborative structures, and potentially new treaty instruments that specifically protect civilian healthcare infrastructure in the digital era.

VIII. Conclusion:

Cyberattacks on the healthcare industry is a severe threat to human safety and put the present legal frameworks on trial. There are still a lot of legal challenges even while international law does offer a framework for controlling cyber activities, especially when in determining when do cyberattacks qualify as "use of force" or "armed attack." Similar to kinetic attacks, some serious cyber operations-those that result in death, destruction, or systemic chaos-may necessitate a reaction under international law, including the right to self-defense. In conclusion, it is important to acknowledge that the healthcare industry is a critical, safeguarded element of international security and in order to avoid unfortunate outcomes in the digital age, it is imperative that states cooperate, strengthen international rules, and increase cyber resilience to protect

⁴⁷. Ibid

⁴⁸. Ibid

"Corporate Governance to Sustainable Governance: Fifty Years Journey of Indian laws"

Harshika Kapoor*

Maneesh Yadav**

ABSTRACT

The following study has focused on the legal journey of India over the fifty years. The study has discussed the rise and fall of the policies and legal frameworks that have made India shift and evolve from a corporate governance to sustainable governance. The first section of the study introduced the need for shifting from corporate governance as it had brought many unfair and illegal activities in the business world. Besides, as India chose to shift from national to a global stage it was important for the businesses to align their operations as per the international forms. Thus, the study has looked into the academic information that is available and has described the change in India's legal setup. The study has discussed case studies that it had collected from secondary data sources and has provided policy recommendations that can be adhered to for strengthening sustainable governance in India.

Keywords: corporate governance, sustainable governance, ESG, SDG, India, Indian laws, business performance, operational efficiency

1. Introduction

India's legal timeline has seen many changes and challenges through the years. The country has followed corporate governance in its early republic stage and has gradually shifted to sustainable governance over the recent years. The change has been a result of challenges in its corporate sector such as 'corporate scandals' and disputes among shareholders (Jain 2022). Hence the following study has focused into the fifty years journey of Indian laws and its balance of corporate governance and sustainable governance. The study would look into how India's governance laws have evolved over the years and how the shift from corporate governance to sustainable governance has allowed the country to catch momentum with global issues.

The idea of 'corporate governance' refers to the follow-up of rules, practices, and processes that a company has to abide by when operating in a country (Van Herpen et al. 2022). In India, effective corporate governance has helped to standardize the professional protocols to manage the country's diverse and rapidly growing economy. This way, India has been able to ensure accountability, fairness, and transparency in a company's relationship with its stakeholders (Jain 2022). The framework of 'corporate governance' has pushed the country to the evils of illegal trade practices. Focused solely on profit-making and ignoring the good fate of the masses, it was important for Indian policies to be reformed (Patel and Deshmukh 2024).

Beginning in 2016, when the United Nations introduced its 'Sustainable Development Goals' (SDGs), the international market began to shift towards a welcome acceptance of the idea of 'environmental, social, and governance' (ESG) along with various corporate practices (Government of Assam. in 2023). India has added itself to the bandwagon as well. Over the years, India has integrated the concept of sustainable governance into its corporate practices while pushing for greater transparency and accountability in its business environment. In 2016, the SDGs became officially recognized as a part of Indian corporate governance (Sodhi et al. 2022). This transition from traditional 'corporate governance' to 'sustainable governance' has empowered India to realize socio-economic and environmental milestones

The study aims to establish the transformational path of India moving from corporate governance to sustainable governance over the past 50 years; while doing so, the study focused on the legal and regulatory milestones that have expanded into this evolution and assessed the socio-economic and environmental impacts of that transition. The objectives of the study are

- To identify the change in India's laws and policies and their impact in shaping corporate and sustainable governance.
- To examine the challenges and benefits that have come in implementing sustainable governance in India.
- To provide recommendations for future governance trends in India.

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2. Literature Review

Corporate Governance Framework in India

Before the liberalization of the Indian economy in 1991, corporate governance in India was predominantly characterized by a focus on regulatory oversight. Companies always play a significant role in the economy. As per the annual report of the ministry, in India, the Company Act of 1956, can primarily regulates the financing, functioning, and formation with winding up of companies (Mca.gov.in 2005). The company act highlights the balance between investors and shareholders, which are competing factors and namely to manage autonomy and also investor protection. In 1956, this act empowered the central government by the procedure of inspecting all account books of a company. Along with that it also directs to a special audit for the purpose of ordering an investigation into the affair of a company and launching prosecution to avoid violation of the Companies Act, 1956.

As per the report of the SEBI government, the establishment of SEBI or Securities and Exchange Board of India was very instrumental for companies to enforce stricter regulations for the purpose of protecting investors' interests. In 2020. Clause 49 introduces the stage for governance modernization by mandating the independence of the board. As per the report SEBI, the composition of the board mentioned that for the purpose of this clause, the independent director could mean a non-executive director of the company who cannot be released for the purpose of promoting and managing at the board level or any lower level of the board (SEBI.gov.in 2021). Not only that, for this clause 'independent director' could be apart from responsibilities like receiving directors remuneration that does not have any transactions or any pecuniary relationships with the company. Non-executive director of the company must not been an executive of the company in the intermediate three financial years. Code of conduct of clause 49 is that it will be obligatory for the company board to maintain for laying down the code of conduct which is for all board members and also for the senior management of the company. Secondly, all board members with senior management personnel could affirm about the compliance in an annual basis of conduct (SEBI.gov.in 2021).

Despite of advancements, corporate governance has faced several challenges in India, such as corporate scandals, removal of independent directors, liability towards stakeholders, accountability issues, performance evaluation of Directors, missing independence of directors, and lack of transparency. As per the report of the International Journal for Multidisciplinary Research or IJFMR, the capital markets regulator of India released the guidance named "Guidance Note on Board Evaluation" in January 2017 (Vyas 2023). It covers several major

perspectives of Board evaluation including the Subject and Process of evaluation. Digitalization privacy with data protection is one of the issues of central governance. To overcome this, the board should be capable to manage and ensure the protection of any data that are raised from misuse.

Transition to Sustainable Governance

As per the perspective of Kandpal and Okitasari, India is known as a diverse and vast country in South Asia that is characterised by rich ethnic diversity, extensive geographical regions, and multiple religious affiliations. As per the Indian governance system, cooperative and competitive federalism work is complementary to SDG localisation (Kandpal and Okitasari 2023). According to the report of UN India, globally, India is determining the success of SDGs. Niti Ayog, is the premier think tank of India that has been entrusted with the task of coordinating the SDGs (India UN 2024). Along with that, it can map schemes which are connected to the targets of SDGs and also identify lead and supporting politicians for each target. In India, the UN country team supports the Niti Ayog with Union ministries and state governments to maintain the efforts for addressing the interconnectedness of the goals. To maintain India's progress, state governments are the key to the SDGs and the reason behind this is that they are the best placed to put people first, which can ensure that there is no one who left behind. According to the report of Niti Ayog by PIB Delhi, targeted interventions like Swachh Bharat, Ayushman Bharat-PMJAY, Pradhan Mantri Awas Yojana, Ayushman Arogya Mandir, Start-up India, Ujjwala, Saubhagya, and PM-Mudra Yojana, all had the impact and led with the rapid development with improvement. As per the press release titled as India Accelerates Progress towards the SDGs Despite Global Headwinds, there is significant progress in achieving goals that are connected with providing decent work, eliminating poverty, climate actions, economic growth and life on hand (Pib 2024). As per the SDG index of 2023 to 2024, there are the fourth editions of the principal tool of the country that are required for measuring national and also subnational progress.

Case Studies

In recent years, Environmental, Social, and Governance (ESG) investing has become an important global trend that can increase number of investors, companies, and governments recognizing the importance of incorporating ESG factors into their decision-making processes. Here are seven companies that have taken various types of important steps in the industry, which is integrating ESG principles into their business practices while setting benchmarks for their peers.

In India, Tata Steel is one of the leading steel manufacturing companies that made several significant developments for the purpose of reducing environmental

impact (TataSteel 2024). It takes initiative through the implementation of projects that can increase the usage of waste plastic in the process of steelmaking. From the report of the Paris Agreement, in the digital service industry, Infosys is a global leader in next-generation and in 2020, it has achieved carbon neutrality (UNFCCC 2023). And set targets by the Paris agreement from the 30 years ahead. India's one of the largest banks, specifically, private sector banks have financed of across 7.6 million by providing vocational training to rural people, who are under the sustainable livelihood initiative. On the other hand, AGEL, which seems ambitious when it comes to achieving goals, is one of the leading companies for renewable energy in India. Unilever Sustainable Living Plan is one of the initiatives that is taken by Hindustan Unilever Limited and also has achieved a 100 % reduction of water abstraction (HUL 2024). Airtel is also committed to achieving gas emissions by 2050 titled 'net-zero greenhouse' (Earth5R 2024). As per the report of Airtel sustainability, it also has been reported since the 2019 about Climate change program (Airtel 2024). Lastly, one of the conglomerates across multiple sectors includes FMCG, paper, and hotels, all have become the key to making it a pioneer in sustainability practices in India.

Research Gaps

The research reveals the evolution in India of corporate governance and emphasises the regulatory frameworks with sustainable initiatives maintaining proper case studies. However, there is a significant gap that is about

the process of understanding the way these frameworks are implemented in mid-sized and smaller enterprises. Along with that, there is the limited glimpse that exists of India's global competitiveness regarding the impact of governance in sustainability.

Theoretical Framework

To understand the theoretical framework, first it represents the integration of governance and sustainability in India. It is divided into three major sections such as corporate governance, transition to sustainable governance, and ESG integration in corporate practices. corporate governance focuses on two major theories and challenges, such as agency theory, and stakeholder theory. Agency theory refers to the independence of the board that defines Clause 49 and accountability with transparency. Then stakeholder theory defines two major processes such as addressing stakeholder needs and board evaluations. On the other hand, challenges refer to any corporate scandals and data protection issues. Secondly, the Transition to Sustainable Governance has two divisions Sustainable Development Goals and some theories to Support the Transition. Institutional theory and systems theory are referring as supporting systems. Niti Ayog is one of the initiatives of key mechanisms and cooperative and competitive federalism are two divisions of transition. Lastly, ESG integration highlights the TBL format and some case studies. In the below section the framework is displayed.

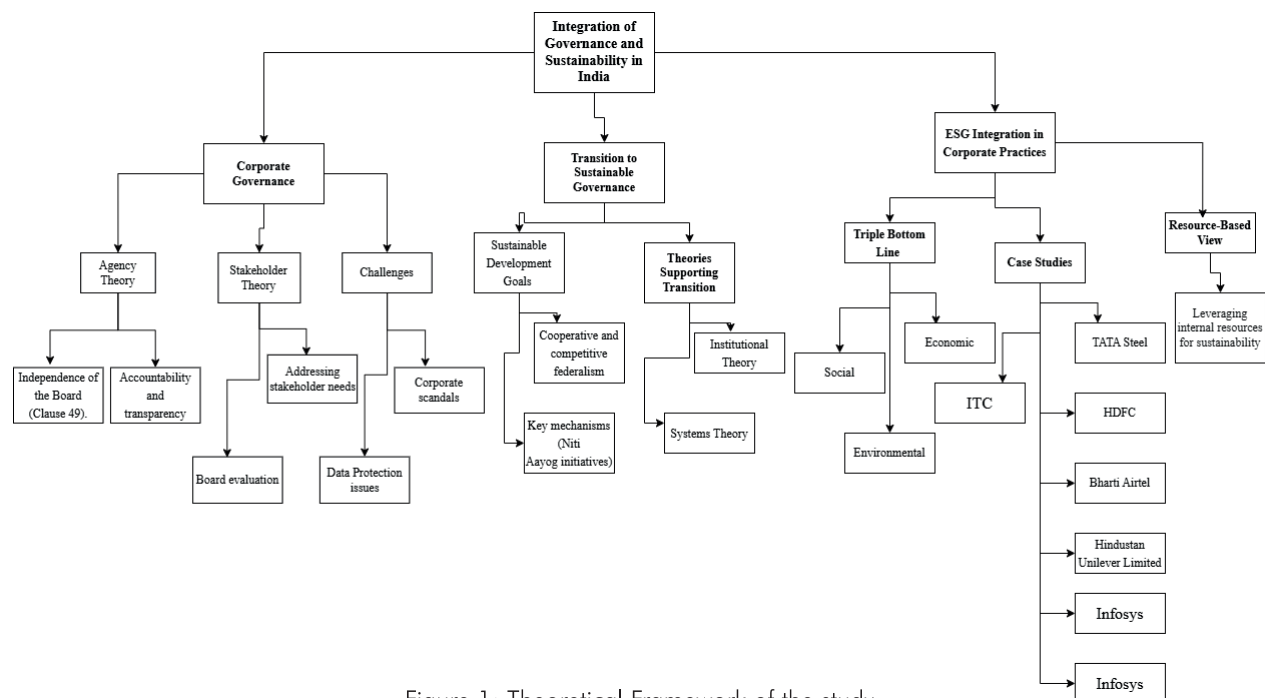


Figure 1: Theoretical Framework of the study
(Source: Self Developed)

3. Methodology

Research Design

The evolution of governance frameworks in India is examined in this study utilizing a secondary qualitative research technique, with a particular emphasis on the shift over the previous 50 years from corporate governance to sustainable governance (Lobo and Noronha 2022). Through the in-depth analysis, the research design involves some legal documents, policy papers, and governance frameworks which can need to be traced for the purpose of development of laws and to maintain their socio-economic implications.

To highlight the practical implementation of government policies and consider its impact, there are several case studies that are of notable Indian corporations, which serve as illustrative instances (Kavadis and Thomsen 2023). Case studies can provide some real-time existence and insights that are about the process which can be followed by TATA Steel, HDFC, Bharti Airtel, Hindustan Unilever Limited, Infosys, Adani Green Energy Limited, and ITC, some multinational corporations. These could have adopted sustainable governance practices and also set benchmarks to broaden any corporate ecosystem based in India.

Data Collection

To discuss about data collection process, the study gathered information and data from various secondary sources which could ensure to strengthened and multidimensional analysis. There are some major key sources that must be included, such as government regulations and legal framework, SEBI guidelines and circulars, academic journals and policy papers, global works and corporate sustainability reports (Gupta 2024). Taken initiatives from SEBI like business responsibility and sustainability reports and clause 49 are known as circular guidelines of SEBI. On the other hand, several documents such as the Companies Act, 2013 related amendments which can provide foundational data on governance transitions. There would be some peer-reviewed industry reports and articles that provide theoretical perspectives with critical evaluation of any governance practices (Al-Okaily et al. 2024). Several reports that provide information on Indian corporations can offer real-world examples, which are into government applications like laws and sustainability practices. Not only that, there would be international standards articles that illustrate references which offer global frameworks.

Data Analysis

Through the thematic analysis, the study aims to detect and interpret some patterns of evolution and trends of the governance frameworks. Coding of collected data for the

purpose of uncovering any recurring themes like accountability, stakeholder inclusion, transparency, and sustainability integration would be required for the analysis (Abhayawansa et al. 2021). To juxtapose any corporate governance practice with sustainable governance, comparative analysis would highlight major differences and transitions as well.

Ethical Considerations

Focusing on the ethical guidelines, the study ensures the integrity and credibility of the entire research. Legal documents, academic publications, and corporate reports are included as secondary data sources, which were cited to maintain the avoidance of respective intellectual property rights (Grimaldi et al. 2021). By maintaining objectivity as well as avoiding misrepresentation and bias of data the study would be conducted. Along with that, there would be less usage of personal and sensitive information, which can eliminate privacy concerns as well. Through this study, it must be maintained that interpretation must be balanced and also reflective to broaden the context. Finally, the research is aligning with ethical standards to establish a secondary qualitative study that could ensure reliability, respect, and most important is transparency for the original data sources.

4. Discussion of Findings

The following section has focused on the insights that are gained from academic discussion and industrial information. The findings from the secondary sources have been analysed and interpreted to understand the journey of Indian legal reforms over the past fifty years.

Legal Milestones in Indian Governance (1970s-2020s)

The journey of Indian legal structure had begun with the enforcement of the 'Companies Act of 1956'. The act had laid the foundation for corporate regulation in post-independent India (Sodhi et al. 2022). The act, at a larger rate, was focused on the rights of the company's shareholders and the disclosures of patent, trademark and other important communication with the public. Hence, the perception was inclined more on the profit-making side of India and not on the welfare of the entire economy. To resolve this, a clause began to be followed for balancing the extreme shift to profit-making. The 'Securities and Exchange Board of India' (SEBI) that was established in 1992 had brought a 'Clause 49' in 2000 for regulating the securities market and protecting the best interests of its investors (Gupta and Saxena 2023). As per the clause, it had become important for the directors of the company to define the role of the senior management, its auditing committees and itself. This was done so that corporate work remains aligned with transparency, accountable actions and ethical processes.

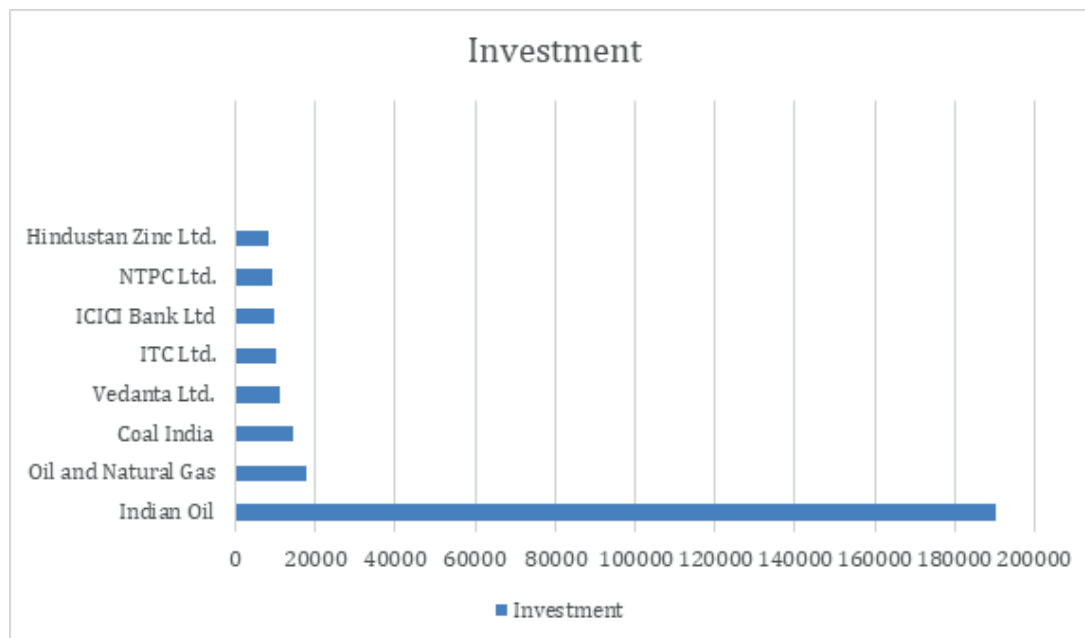


Figure 2: Investment of Indian Companies in SDG

As per academic insights the role of 'Companies Act, 2013' is huge in redesigning 'corporate governance'. By following 'Companies Act, 2013', the 'corporate governance' was defined by the role of a companies directors, auditing committees and shareholders. This is when 'corporate social responsibility' (CSR) was first introduced in Indian laws for corporate governance. One of the most striking features of 'Companies Act, 2013' is the creation of a financial threshold (Gangwal and Koolwal 2023). The act has bound companies to allocate at least 2% of their average net profits from the previous three years (Acharya 2024). This has to be invested in CSR activities and must be added on the annual report of a company's performance. As per SEBI.gov.in (2021), the

board has chosen to introduce the 'Business Responsibility and Sustainability Report' (BRSR) which has again bound companies to show how far they have included the ESG practices in their operations. Thus, it can be said that over the timeline the Indian corporate boards have consciously and actively made reforms in their policies. This is how India and its companies have been able to promote responsible business practices and provide its stakeholders transparent and genuine information for assessing corporate sustainability efforts.

As per academic studies the following table has shown the key legal milestones in India:

Law Introduced	Year
Securities and Exchange Board of India (SEBI) Act	1992
Companies Act	2013
National Voluntary Guidelines on Social, Environmental, and Economic Responsibilities of Business	2011
SEBI's Mandate for Business Responsibility Reporting	2012

Table 1: Legal Milestones in India (Gupta and Saxena 2023)

Analyzing the Drivers of Change

The laws and policies that have shaped the approach of Indian governance are related to the awareness of the environment and globalization. India's economy in the 1990s became more liberal and began to show its presence in the global markets more dominantly. However, the globalization of business made the companies adopt international approaches and standards. One of the biggest concerns in the international

market was to focus on environmental stewardship and sustainable development. Thus, India too had to align with the operations with sustainable principles so that it could get favourable partnerships and collaborations with major players in the international market like Procter & Gamble, Walmart and Coca-Cola (FinHacker 2021).

Some other partnerships are:

Initiatives:

Name of Indian Company	International Partner	Year of Partnership
Renew Power	Goldman Sachs	2010
Steel Authority of India (SAIL)	BHP Group	2024
International Solar Alliance (ISA)	Various Countries	2023
Saatvik Solar	Asian Development Bank	To be partnered in 2025

Table 2: International Partnerships of India (Sethuraman 2024)

Apart from the need to include eco-friendly and sustainable policies in business portfolios, it was also important for India to maintain transparency in its operations. Industry reports have shown how high-profile corporate scandals, like the 'Enron Scandal' of 2001 or the 'Polly Peck Scandal' of 1990 had curbed the trust and goodwill of many companies (Rashid 2021). Thus, the international market had a strict approach against financial misreporting and ethical breaches. Thus, India also had to make its account disclosure and performance report transparent and accountable.

The role of the 'Paris Agreement 2016' is also huge in

which India and other countries have signed. For sustaining climate change, ensuring that factory fumes and industry activities do not harm water, air and soil, the 'Paris Agreement' had urged nations to collectively work together and limit global warming (Schoonees 2022). The impact of SDGs can also not be overlooked. It had urged nations to adopt business practices that would actively contribute to global sustainability targets. Thus, as understood through the industry reports, Indian companies like 'Hindustan Unilever Limited', 'Bharti Airtel', 'HDFC Bank', 'Adani' and 'Tata Steel' and 'ITC' and many others have aligned their activities to follow the international commitments.

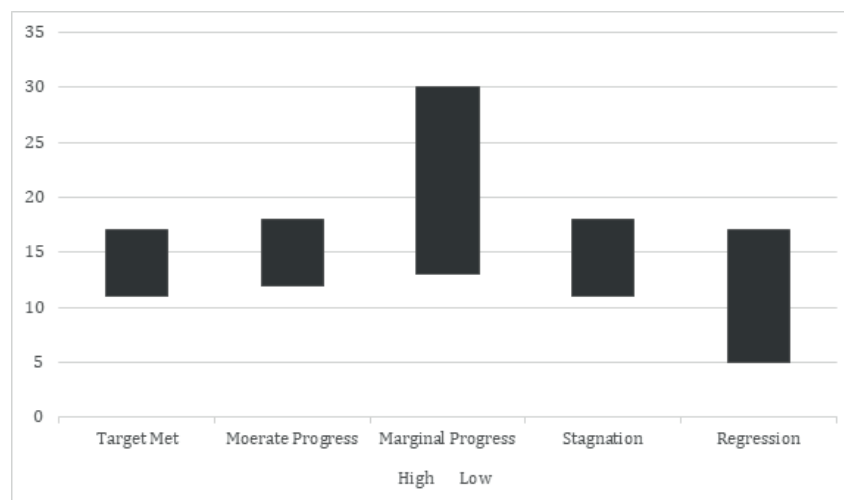


Figure 3: Data on Fulfillment of SDGs

Challenges and Benefits

Despite the fact that companies themselves develop their sustainability models and choose how to integrate them into their operations, companies often feel tied. Many stakeholders believe that adopting ESG practices can raise their cost of maintenance and bring in additional costs (Macey 2022). This is sheer lack of awareness and communication of the long-term benefits of sustainability. Furthermore, companies often do not monitor their activities. Indian companies that do not have proper standards of sustainable governance fail to manage their sustainability standards. It is important for companies to develop a proper oversight of their actions so that they can implement their sustainability initiatives effectively. Moreover, some companies in India have failed to manage their profitability and break-even points. As it is important to balance short-term profitability with long-term sustainability objectives, companies which cannot do that fall victim to operational inefficiencies and damaged brand reputation.

In contrast to the challenges that sustainable governance brings for companies, it has many benefits as well. As companies like Infosys and Tata Steel follow an ethical conduct and keep their performance transparent, it is easier for them to get investors, customers, and the public. The adoption of sustainable governance contributes to long-term socio-economic and environmental gains (Mathur and Maharishi 2023). As per industry reports, it is evident that following ESG rules can help companies to achieve better management of risks, have better management of operations and a positive social impact (Macey 2022). By adopting 'sustainable governance' companies like 'Wipro' and 'HDFC Bank' have attracted more international investments and partnerships for thriving in the market.

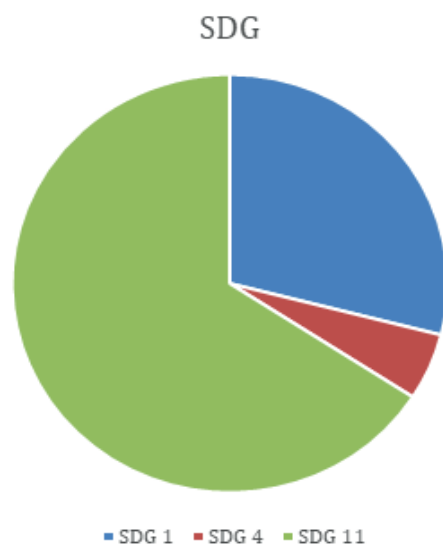


Figure 4: Reliance and SDG of Eradicating Poverty

Case Studies from Indian Industries

Several Indian companies have shown an active stewardship towards adopting sustainable governance in their operations. 'Hindustan Unilever Limited' (HUL) has made good progress by bringing ESG through its 'Unilever Sustainable Living Plan.'. The company made sure that they can reduce wastage of water by 100% and greenhouse gas at the same point of time (Earth5R.org 2024). Bharti Airtel too had taken the initiative to achieve a zero percent of greenhouse gas emissions by the year 2050. In doing so, the company had reduced the energy consumption by 15% within three years. HDFC Bank also has included ESG considerations into its operations very sincerely. It has also followed the SDGs in its sustainable governance and has funded for developing 7.6 million rural households (Sumaya 2021). Further, they also had taken the initiative of giving training to lakhs of people. These activities of the bank show their focus on sustainable financing, financial inclusion, and community development. HDFC is not only focused on building their company but they are as much focused on promoting social welfare programs.

The Adani Group, Tata Steel and ITC are one of the most important players of the Indian market. They have seen the transition of Indian laws from 'corporate governance' to 'sustainable governance'. Adnani's contribution to sustainable governance is not limited to its home ground. The company had focused on planting 484 MW of wind power in a contract with Sri Lanka. This investment had cost them USD 740 million and is expected to be finished by 2026 (FE Business.com 2025). This investment on solar and wind energy projects has been a very big step and has shown what sustainability stewardship looks like. Tata Steel and its contributions are many.

The company has reduced its gas emissions within four years by 13% and has also discarded the use of plastic as far as possible. The company has also focused on renewable energy adoption and has been recognised for its efforts in integrating ESG principles into its operations (Earth5R.org 2024). ITC has also embraced a comprehensive approach to sustainability. Their focus has been on investing more on environmental conservation, social development, and economic growth. The company's initiatives also include afforestation programs, water stewardship, and sustainable agricultural practices. As per The CSR Journal (2023), ITC has made efforts that lead to significant positive impacts on rural livelihoods and environmental conservation by covering a land area of more than eight lakh acres to create employment for rural areas.

5. Conclusion

The transition from corporate management to responsible governance in India is the result of a historical change that

has taken place over the past fifty years. The Companies Act of 2013 marked a watershed moment with the CSR provisions and the audit requirements on social and environmental performance, as corporations had to account for their actions and impacts. Likewise, SEBI's Clause 49 and BRSR have enforced rules on non-financial reporting and business ethics, which has changed the corporate culture to one which accepts these principles. Processes like decision-making would greatly benefit from the use of blockchain, as it would improve accountability and trust in the system. Innovation could be beneficial for bridging all gaps through policy implementation and also fostering trust that are among stakeholders. Not only that, for proper stakeholder engagement, integrating digital platforms could be improved through accountability and responsiveness as well.

For the purpose of strengthening, the sustainable governance of India, there are several policy recommendations which could be considered as the first choice. First of all, through the establishment of stronger mechanisms and penalties for non-compliance, the government would enhance its enforcement of existing laws. Secondly, innovation in sustainable practices could be driven by fostering public-private partnerships. Next, tax benefits is one kind of providing incentive for companies through which companies can adopt ESG frameworks that would enhance broader participation. And lastly, in sustainable governance, effective implementation at all levels could be ensured by making investments in capacity building and education which are required to train professionals. India can lead through instances of integrating sustainability that is into government practices by developing the legal milestones that achieved. This approach would not only drive long-term and sustainable business success but also make the contribution to the nation's social and environmental prosperity and also achieve a balance between economic growth and sustainability.

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Biotechnology and Artificial Intelligence: Emerging Legal Issues

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ABSTRACT

"I want Chitti Robot!" exclaimed a medical aspirant preparing for the PG NEET exam. Her words made me pause and reflect—was she expressing fatigue from the long hours spent studying an overwhelming syllabus, or was she yearning for a tool, a technological companion to assist her in the process? It was in that moment I realized the distinction: the human brain is adaptive, emotional, and context-driven, whereas artificial intelligence is a blend of emerging technologies, advanced software systems, and, most importantly, rigorous data-driven algorithms.

Every newspaper, magazine, and online platform is abuzz with discussions about AI. In today's fast-paced world, AI is indeed making daily life faster, more convenient, efficient, and personalized. However, this growing reliance also raises an important concern—dependence. Over time, such dependence can become a double-edged sword, something that individuals may only begin to recognize as its impact deepens.¹

Introduction: Artificial Intelligence

Artificial Intelligence (AI) is about teaching computers to do things that humans are currently better at. While computers are great at handling large amounts of data, they often lack basic common sense—the kind of everyday understanding that humans take for granted. For example, an AI program might know more facts than a regular accounting software, but it still works with basic instructions without really understanding what they mean. That's why one of the main goals in AI is to help machines represent and use common sense knowledge in a meaningful way.

We, as humans, perceive our environment through many senses—sight, sound, touch, smell, and taste. Among these, vision and spoken language are especially important. It is through seeing and listening that we acquire most of the knowledge that shapes our thinking and helps us solve problems. For AI to become truly intelligent, it needs to process and understand information through various channels, just as humans do.

Keywords: Artificial Intelligence (AI), Human–machine interaction, Technological dependence, Common sense reasoning in AI, AI limitations, Automation in education

Examples of AI Lacking Common Sense

When a user inquires whether they should rely on a large language model like ChatGPT for stock market investing advice, the AI provides a response based on its programming. In another area, AI is solving one of archaeology's most challenging puzzles.² Not only is it aiding in the discovery of more geoglyphs, but it's also revolutionizing how archaeologists explore ancient civilizations. Traditionally, archaeologists used methods like ground-surface photography and manual mapping to study these sites. Dr. João Fonte, an archaeologist at ERA, highlights that archaeology is now leading innovation by

embracing digital tools.

The Supreme Court has raised concerns about the potential loss of employment due to AI-driven vehicles, particularly as judges deliberated on policies regarding the promotion of such technologies in the market. One of the key concerns is that many drivers may lose their jobs as a result.³ This issue extends beyond the transportation sector, as AI is increasingly replacing human roles in areas like content writing, consultancy, and various other businesses. The rise of AI startups further intensifies the debate, suggesting that AI could replace human workers in many industries.

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¹ Elaine Rich, *Artificial Intelligence* (2d ed. 2003) (Tata McGraw-Hill Publishing Co. Ltd.).

² Lydia Amazour, *Artificial Intelligence Solves Archaeology's Greatest Puzzle*, *The Daily Galaxy*, Apr. 21, 2025, <https://dailygalaxy.com/2025/04/artificial-intelligence-archaeology-puzzle/>.

³ Supreme Court Says Artificial Intelligence Will Take Job of Drivers and Lawyers, *Live Hindustan*, Apr. 21, 2025, <https://www.livehindustan.com/national/supreme-court-says-artificial-intelligence-will-take-job-of-drivers-and-lawyers-201745315755214.html>.

⁴ Best AI Tools for Lawyers in 2025, *Analytics Insight*, Apr. 21, 2025, <https://www.analyticsinsight.net/artificial-intelligence/best-ai-tools-for-lawyers-in-2025>.

In the legal sector, AI tools have already become indispensable. Modern law firms are leveraging AI-powered tools like ROSS Intelligence, Kira Systems, and Clio to streamline workflows, enhance efficiency, and improve decision-making. These tools enable lawyers to focus on more strategic tasks and deliver better outcomes for clients.⁴ As AI technology continues to advance, its integration into the legal field is expected to grow, reshaping the future of legal practice. However, as Justice Surya Kanth reminds us, AI systems, while powerful, still carry inherent biases. After all, AI is a man-made creation.⁵

Biotechnology

The term biotechnology has been defined, it essentially represents the use of microbial, animal, or plant cells or enzymes to synthesize breakdown or transform materials.

Biotechnology has benefited medical and health sciences (diagnostics, vaccines, therapeutics, foods), agricultural sciences (improved crop yield, food quality, improved animal health) and environmental sciences (pollution control, environmental monitoring, bioremediation).

Evolution of Biotechnology with AI

The integration of Artificial Intelligence (AI) has greatly accelerated the progress of biotechnology, particularly over the past twenty years. In the early 2000s, AI had only a limited presence in biotech, with its role confined mostly to basic data analysis and computational support. During the Human Genome Project, for instance, AI tools aided in aligning large-scale genetic sequences and improving the accuracy of genome mapping- marking one of the earliest collaborations between AI and biotechnology.

The 2010s witnessed a surge in biological data, driven by breakthroughs in next- generation sequencing (NGS), proteomics, and advanced imaging techniques. This explosion of data created a natural space for AI to expand its utility. Machine learning began to support the prediction of gene expression, protein structure modeling, and interpretation of complex medical images. Notably, AI systems like IBM Watson entered clinical settings, assisting in oncology by recommending personalized treatment plans based on patient-specific genetic data. This signaled a pivotal shift toward more individualized approaches in medicine.

By the 2020s, deep learning technologies began to redefine the landscape of biotechnology. AI became a central tool in drug discovery, exemplified by DeepMind's AlphaFold, which made significant progress in accurately predicting protein folding. Concurrently, AI enhanced the

accuracy of gene-editing techniques such as CRISPR by anticipating possible off-target effects, making genetic interventions more precise. Startups like Insilico Medicine and Recursion embraced AI-driven platforms to identify and refine potential drug candidates quickly and cost-effectively.

In more recent years, the fusion of AI with synthetic biology has paved the way for innovative developments. AI is now employed to engineer new biological systems, design synthetic organisms, and optimize manufacturing processes like fermentation and cellular engineering. Real-time lab automation, powered by AI and robotics, is further transforming the research and development process by enabling faster experimentation and data analysis.

Looking to the future, biotechnology's trajectory is inextricably linked with AI advancement. We are approaching a time when AI may fully automate the design, testing, and production of vaccines and therapeutic compounds. With the rise of quantum computing, AI-powered bioinformatics is poised to unravel even the most intricate biological questions. Emerging innovations-ranging from AI-driven prosthetics to smart implants and custom-designed enzymes-are expected to become increasingly mainstream. Ultimately, AI is evolving beyond a supporting tool to become a foundational force that reshapes how we explore, understand, and harness the potential of life itself.⁶

Areas of Biotechnology

The biotechnological field is often divided into diverse and specific area of study. The green sector that is called as agricultural sector, which covers the topics of plants and agricultural techniques. The red sector which is of health focuses, which focuses on health, medicine, therapeutics etc. The white sector which is also called as industrial biotechnological sector, which focuses on industrial branch and the blue sector which comprises everything that involves aquatic and marine systems.

Green Biotechnology (Agricultural Sector) and AI Applications

Green biotechnology uses AI to improve farming, crop management, and food production. One major application is AI-powered weather forecasting, which helps farmers plan their planting, irrigation, and harvesting schedules based on accurate climate predictions. AI also analyzes soil conditions, detects plant diseases through drone and satellite imagery, and predicts crop yields. Additionally, machine learning models are used to breed

⁵ Supreme Court's J. Surya Kant: Artificial Intelligence, a Man-Made Machine, Has Very Serious Biases, LiveLaw, Apr. 21, 2025, <https://www.livelaw.in/top-stories/supreme-court-j-surya-kant-artificial-intelligence-man-made-machine-has-very-serious-biases-290135>.

⁶ John Jumper et al., Highly Accurate Protein Structure Prediction with AlphaFold, 596 Nature 583 (2021), <https://doi.org/10.1038/s41586-021-03819-2>.

genetically improved crops that are more resistant to drought, pests, and extreme weather conditions. These innovations help increase productivity, reduce crop losses, and support sustainable agriculture.

Red Biotechnology (Healthcare Sector) and AI Applications

In red biotechnology, AI plays a major role in advancing healthcare and medicine. It is used in drug discovery to predict how a new drug will interact with the human body, helping scientists find effective treatments more quickly. AI has also significantly contributed to COVID-19 vaccination plans, where AI models were used to predict protein structures of the virus, accelerating vaccine development. In addition, AI tools are utilized in diagnostic tools like analyzing X-rays, MRI scans, or genetic data to detect diseases such as cancer, including breast cancer, at an early stage. AI is also applied in in vitro fertilization (IVF), optimizing embryo selection and improving success rates. Additionally, AI is enhancing gene editing technologies like CRISPR by predicting the outcomes of genetic modifications and minimizing off-target effects. The power of AI also extends to the discovery of aging biomarkers, allowing scientists to identify and understand the genetic and molecular factors that contribute to aging. Furthermore, personalized medicine-creating treatments based on individual genetic profiles-is made possible by AI algorithms, enabling more effective and tailored therapeutic approaches. Moreover, AI has been used for TB screening at large public health events, such as the Maha Kumbh Mela, where AI-powered tools helped identify individuals with tuberculosis (TB), supporting efforts to control the disease in high-risk environments. This application highlights AI's potential in public health and disease management.⁷

White Biotechnology (Industrial Sector) and AI Applications

White biotechnology benefits from AI by making manufacturing processes smarter and more efficient. AI can monitor and control large-scale fermentation processes, including solid-state fermentation, used in producing biofuels, enzymes, or food additives. In solid-state fermentation, microorganisms grow on solid materials without free-flowing liquid, making it more sustainable and efficient for certain products like enzymes and biofuels. AI helps optimize production by analyzing data from sensors in real-time, reducing waste and energy usage. For instance, AI can predict equipment failures in factories or suggest changes to improve yields, making the production process more sustainable and cost-effective. Additionally, AI is playing a significant role in the cannabis

industry, where it assists in optimizing cultivation conditions for enhanced health benefits. AI helps in predicting the most effective cultivation medium and environmental parameters to maximize the therapeutic properties of cannabis for patients. AI also ensures food safety by monitoring the quality of cannabis products, detecting contaminants, and ensuring compliance with health standards. The rise of smart factories, powered by AI, has transformed industrial biotechnology. These factories leverage AI-driven automation, robotics, and advanced analytics to streamline operations, enhance precision, and reduce human error. Smart factories not only improve efficiency but also enable real-time adjustments in production processes, enhancing the scalability of biotechnological solutions and reducing environmental impact.

Blue Biotechnology (Marine and Aquatic Sector) and AI Applications

In blue biotechnology, AI helps explore and utilize marine life for beneficial purposes. AI tools can scan large ocean datasets to identify new marine species that may be useful for making medicine or food supplements. It can also help in tracking ocean pollution and the effects of climate change on marine ecosystems. Drones and underwater robots powered by AI are used to study coral reefs, monitor fish populations, and support sustainable fishing practices. AI is also employed to monitor culture behavior in marine organisms, such as fish and shellfish, to detect signs of stress or infection. By analyzing these behaviors, AI can predict and prevent culture loss, ensuring the health and sustainability of aquaculture systems. This application not only supports the sustainable management of marine resources but also contributes to the development of healthier, more resilient aquatic species.

Advantages of AI in Biotechnology

Artificial Intelligence (AI) has brought transformative advancements to the biotechnology sector, enhancing both efficiency and innovation. One of the most significant benefits is the acceleration of research and development. AI can rapidly process complex biological datasets-such as genomic sequences or protein structures-reducing the time required for discoveries that once took years.

AI also enables increased precision in biotechnological applications. For example, in gene editing or drug development, AI algorithms help predict outcomes with high accuracy, minimizing trial-and-error experimentation. In personalized medicine, AI assists in tailoring treatment strategies based on an individual's genetic and clinical profile, improving patient outcomes.

⁷ Qure.ai, AI-Powered TB Screening Supports Public Health Efforts at Maha Kumbh Mela, Qure.ai, https://www.qure.ai/news_press_coverages/AI-Powered-TB-Screening-Supports-Public-Health-Efforts-at-Maha-Kumbh-Mela.

Another major advantage is cost-effectiveness. By automating repetitive processes and optimizing resource usage, AI significantly reduces operational costs. In bioprocess engineering, AI models help manage fermentation, enzyme production, and other manufacturing processes by predicting equipment failures and adjusting parameters in real time to maximize yield.

AI further enhances data integration by connecting diverse biological data types- such as clinical, environmental, and omics data-into a single analytical framework. This holistic view supports better decision-making in everything from agriculture to therapeutics.

Disadvantages of AI in Biotechnology

Despite its many benefits, AI integration in biotechnology poses several challenges. A primary concern is the risk of data bias and inaccuracy. AI systems learn from existing datasets, which may include errors, outdated information, or represent only limited populations. Such bias can lead to misleading conclusions or unsafe outcomes, especially in healthcare applications.

The lack of transparency in AI decision-making-often called the "black box" problem-can also be problematic. Biotech professionals and regulators need to understand how an AI system arrives at a particular recommendation, especially when public health is involved.

There is also concern about ethical and privacy issues, particularly when AI systems handle sensitive patient or genetic data. Without robust data protection policies, there's a risk of breaches or misuse of confidential information.

High implementation costs and the need for specialized technical knowledge present additional barriers, especially for smaller biotech firms. Establishing AI-driven systems often requires significant investment in infrastructure and workforce training.

Lastly, over-reliance on AI tools could lead to reduced critical thinking and human oversight in research and diagnostics. While AI is a powerful assistant, it cannot replace the nuanced judgment of experienced professionals.⁸

Why Do We Need Laws for AI in Biotechnology?

As artificial intelligence becomes more deeply integrated into biotechnology, especially in sensitive areas like healthcare, drug discovery, genetics, and diagnostics, the need for strong legal frameworks becomes critical. AI tools are capable of making decisions based on large volumes of biological and health data. However, these tools can also malfunction, make biased decisions, or be misused-

raising concerns about accountability, ethics, and data protection. For example, if an AI system misdiagnoses a patient or suggests an inappropriate treatment, it can have life-threatening consequences.

Therefore, it becomes necessary to establish legal boundaries that define responsibilities, ensure the ethical use of AI, and protect human rights.

Laws are essential not just to manage risk, but also to build public trust in AI- powered biotech solutions. They help clarify who is liable when errors occur and ensure that individuals have control over their personal data. As biotechnology increasingly relies on AI for breakthroughs, regulation is necessary to ensure these innovations are not only effective but also safe, transparent, and fair.

Where Do We Require AI Laws in Biotechnology?

Laws are required in several key areas where AI interacts with biotechnology. First and foremost is data privacy. AI systems in biotech rely heavily on collecting and analyzing sensitive data such as genetic codes, medical histories, and test results. Without strict laws to govern how this data is stored, shared, and used, there is a significant risk of misuse or data breaches.

Another critical area is medical liability. If an AI system makes a wrong prediction or decision, such as recommending an ineffective drug or misinterpreting diagnostic results, it can result in patient harm. Laws are needed to determine whether the liability lies with the developers of the AI software, the hospital or clinic using it, or the healthcare professional supervising the process.

Informed consent and transparency are also essential. Patients and research participants should know how their data will be used by AI systems and be given the option to opt out. Additionally, AI algorithms must be explainable- users should understand the basis of their recommendations.

Bias and discrimination in AI decisions also present a major legal challenge. If the training data is not diverse or balanced, the AI may produce outputs that favor certain groups over others. In biotechnology, this can lead to unequal healthcare treatment. Legal safeguards are necessary to ensure AI systems are developed and audited for fairness.

Lastly, intellectual property rights (IPR) need legal clarity. AI may contribute to the development of new drugs or biological products. Defining who owns these AI-generated discoveries-whether it's the researcher, the institution, or the AI tool's creator- is still a grey area that law must address.

⁸ Anushree Sahoo et al., Potential Impacts of Artificial Intelligence (AI) in Biotechnology, ResearchGate (2023), https://www.researchgate.net/publication/387167565_Potential_Impacts_of_Artificial_Intelligence_AI_in_Biotechnology.

What Legal Frameworks Exist in India?⁹

Information Technology Act, 2000

The Information Technology (IT) Act serves as India's foundational legislation for electronic transactions and digital governance. While it doesn't explicitly mention AI, certain provisions are relevant:

- **Section 43A:** Mandates compensation for failure to protect sensitive personal data, which is pertinent when AI systems process user data.
- **Section 73A:** Addresses penalties for publishing false digital certificates, which could be applicable in AI-related digital authentication scenarios.

Personal Data Protection Bill, 2019

This bill aims to establish a comprehensive framework for personal data protection in India. Key features include:

- **Consent and Purpose Limitation:** Requires explicit consent for data processing and restricts usage to specified purposes.
- **Data Localization:** Mandates that certain sensitive personal data be stored within India.
- **Automated Decision-Making:** Introduces provisions addressing profiling and automated decision-making, requiring transparency and accountability when AI algorithms significantly impact individuals' rights and interests.

Judicial Recognition of Privacy Rights

In the landmark case of Justice K.S. Puttaswamy (Retd.) v. Union of India (2017), the Supreme Court recognized the right to privacy as a fundamental right under the Constitution. This judgment underscores the necessity of safeguarding personal data, especially when processed by AI systems in biotechnology.

Intellectual Property Rights

The Indian Copyright Act, 1957, protects original literary, artistic, musical, and dramatic works. With the advent of AI-generated content, questions arise regarding authorship and ownership. While the Act doesn't currently address AI-generated works explicitly, discussions are ongoing about potential amendments to accommodate these developments.

AI & Patent

The Indian Patents Act, 1970, governs patent law in India. According to Section 6 of the Act, a patent application must be filed by a "person" who is either the true and first inventor or an assignee.

The definition of "person" under the General Clauses Act of 1897 refers to a natural or legal entity, excluding AI

systems. Section 2(y) defines "patentee" as a person who is granted a patent.

Section 2(1)(i) an invention is "a new product or process involving an inventive step capable of industrial application."

The inventive step must involve human ingenuity, further strengthening the argument that AI cannot be granted patents under the current legal regime.

AI & Copyright - Issues

The question of whether Artificial Intelligence (AI) can hold copyright for its original creations has become a subject of global debate. AI, being an automated content creator, produces outputs that may appear original or creative. However, under existing legal frameworks, particularly the Indian Patent Act, Section 2(i), an "inventor" must be a natural person. This means that while AI can assist in inventing or creating, it cannot be considered an author, applicant, or inventor in its own right. Simply put, without human involvement, AI cannot claim ownership of intellectual property.

This has led to discussions on whether AI could at least be recognized as a co-author, sharing authorship with a human creator. However, current copyright laws emphasize the requirement of human creativity and authorship, making it difficult to grant such recognition.

A parallel can be drawn with a landmark U.S. case involving a monkey named Naruto. In this case, wildlife photographer David Slater was accused of infringing the copyright of a selfie taken by Naruto, a crested macaque. The court ruled that non-human beings cannot hold copyright; as only natural persons qualify under the law. Although Slater won the case, he voluntarily agreed to donate 25% of future earnings from the monkey selfies to charities protecting animals like Naruto.

Similarly, in the context of AI, despite its ability to create content, ownership and copyright protection remain tied to human agency, and not to the machine or algorithm itself.

Juristic personality of AI

Juristic personality or legal personhood refers to the status of an entity (human or non-human) that allows it to hold rights and obligations under the law, such as the ability to enter into the contracts, own property and be held accountable. AI is not generally recognized as a legal person in most jurisdictions, including India. AI can't enter contracts, potential for abuse and can't be held liable - not capable of rights and obligations.

Absence of Comprehensive AI-Specific Legislation

As of now, India lacks dedicated legislation that specifically addresses AI. While existing laws like the IT Act and the

⁹ Legal Service India, "Laws Governing AI in India - Everything You Should Know," <https://www.legalserviceindia.com/legal/article-13111-laws-governing-ai-in-india-everything-you-should-know.html> (last visited May 4, 2025).

proposed Personal Data Protection Bill touch upon aspects related to AI, they don't comprehensively cover the unique challenges posed by AI technologies, especially in sectors like biotechnology.

Government Initiatives and Ethical Guidelines

India has recognized the transformative potential of Artificial Intelligence (AI) and has launched several initiatives to promote its responsible development and application, particularly in areas that can impact society at large.

National e-Governance Plan (NeGP):

The National e-Governance Plan aims to digitally empower Indian society by delivering government services electronically. AI plays a pivotal role in improving the efficiency, transparency, and accessibility of these services. Various government departments have adopted AI technologies to automate routine tasks, support data-driven decision-making, and provide personalized services to citizens.

New Education Policy (NEP):

The New Education Policy launched by the Government of India includes forward-looking provisions to nurture technological skills from an early age. It introduces coding classes for students starting from Grade 6 and promotes computational thinking and digital literacy. This aligns with the broader vision of establishing India as a global innovation and technology hub.

AIRAWAT (AI Research, Analytics and Knowledge Assimilation Platform):

Launched by NITI Aayog, AIRAWAT serves as a comprehensive platform for AI research and development in India. It is designed to address the infrastructure and policy needs essential for AI innovation, including compute power, data access, and collaboration between academia, industry, and government bodies.

Ministry of Electronics and Information Technology (MeitY) Initiatives:

MeitY has taken a proactive approach toward addressing the ethical and social implications of AI. Two key policy frameworks have been introduced:

- **National Strategy for Artificial Intelligence:**

This strategy provides a roadmap for the responsible adoption of AI across sectors such as healthcare, agriculture, education, smart cities, and transportation, ensuring inclusive growth.

- **Principles for Responsible AI:**

These principles emphasize the ethical use of AI, focusing

on key values such as transparency, accountability, fairness, privacy, and safety. The aim is to ensure that AI technologies are designed and deployed in a way that upholds public trust and human rights.

Loopholes in the Legal System of AI in India¹⁰

While India is making progress in adopting Artificial Intelligence (AI), its legal and regulatory framework still has several gaps. These loopholes can create confusion, limit accountability, and lead to misuse of technology. Some major issues include:

No Specific Law for AI:

India does not yet have a dedicated law that deals only with AI. While some existing laws-like the Information Technology Act, 2000, and the upcoming Personal Data Protection Bill, 2019-do mention aspects of AI, they do not fully address the complex and unique challenges AI presents. This leaves many legal questions unanswered.

Lack of Ethical Rules:

There are no clear or enforceable ethical guidelines in India to ensure AI is used in a responsible and fair manner. Without proper standards, companies and developers may use AI in ways that are not consistent or may even be harmful.

Risk of Bias and Discrimination:

AI systems are trained using historical data, which can sometimes reflect existing social biases. This can lead to unfair or discriminatory outcomes. Unfortunately, Indian laws currently do not have clear provisions to deal with such problems in AI algorithms.

Accountability Is Unclear:

AI systems are complex and can make decisions on their own. If something goes wrong-like an AI-powered car causing an accident-it's hard to say who is responsible. Indian laws don't clearly explain how to assign blame or responsibility in such situations.

No Dedicated AI Regulator:

Although the Personal Data Protection Bill proposes a Data Protection Authority, there is no specific government body in charge of regulating AI. This lack of focused oversight can result in weak monitoring and poor enforcement of rules related to AI.

Confusion Over Intellectual Property (IP) Rights:

There is uncertainty about who owns the rights to AI-generated inventions or content. Since current copyright and patent laws assume a human creator, it's unclear how to treat work created by an AI. This issue, known as "attribution," needs clear legal answers.

¹⁰ Legal Service India, Laws Governing AI in India - Everything You Should Know, <https://www.legalserviceindia.com/legal/article-13111-laws-governing-ai-in-india-everything-you-should-know.html> (last visited May 4, 2025).

Lack of AI-Specific Legislation:

India currently does not have a dedicated law focused specifically on Artificial Intelligence. This creates a legal gap in addressing the unique privacy and ethical concerns that arise from the use of AI technologies. In contrast, regions like the European Union have proposed comprehensive legislation, such as the AI Act, which provides clear rules for the safe and responsible use of AI.

Lack of Transparency in AI Decision-Making:

Present Indian laws do not require companies or government agencies to disclose how AI systems make decisions. As a result, individuals affected by automated decisions—such as being denied a loan or job—often have no way to understand or challenge the reasoning behind those decisions.

No Defined Standards for Algorithmic Accountability:

There are no formal legal standards in India that require companies to take responsibility for the outcomes of their AI algorithms. Without such rules, it becomes difficult to ensure that AI systems are fair, safe, and do not violate individuals' rights. This lack of accountability also means that companies may not feel obligated to design ethical and transparent AI systems.

In India, where digital adoption is surging and data privacy regulations are still in development, the intersection of AI and data privacy is particularly relevant. The country has recently enacted the Digital Personal Data Protection (DPDP) Act, 2023, which aims to safeguard individuals' personal information in an increasingly digital environment. However, this legislation does not fully address the unique challenges posed by AI, such as algorithmic bias, lack of transparency, and issues of accountability in automated decision-making. These gaps have significant implications, as AI applications become more prevalent in sensitive areas like healthcare, finance, and law enforcement.¹¹

Conclusion

The convergence of biotechnology and artificial intelligence represents one of the most transformative developments of the twenty-first century. Together, these disciplines are reshaping healthcare, agriculture, industry, and marine science, offering unprecedented opportunities for innovation, efficiency, and precision. From accelerating drug discovery and enabling personalized medicine to enhancing sustainable agriculture and optimizing industrial processes, AI-powered biotechnology has emerged as a cornerstone of future progress.

However, this rapid advancement brings equally significant legal, ethical, and regulatory challenges. Issues of data privacy, algorithmic bias, transparency, intellectual property rights, and liability in AI-assisted decisions underscore the urgent need for a comprehensive legal framework. While India's existing laws, such as the Information Technology Act, 2000, the emerging Personal Data Protection regime, and established IPR statutes, provide partial coverage, they remain inadequate to address the complex realities of AI-driven biotechnology. The absence of AI-specific legislation, clear ethical guidelines, and robust regulatory oversight creates risks that could undermine both public trust and the safe deployment of these technologies.

As we stand at this critical juncture, it is imperative to strike a balance between fostering innovation and safeguarding public interest. Lawmakers, policymakers, scientists, and industry stakeholders must work collaboratively to design adaptive, forward-looking regulations that ensure accountability, protect fundamental rights, and encourage responsible use of AI in biotechnology. By implementing transparent, ethical, and enforceable legal measures, India can not only mitigate the risks associated with these emerging technologies but also position itself as a global leader in harnessing AI-biotech synergies for societal and environmental good.

The promise of biotechnology empowered by artificial intelligence is vast—but its success will depend on our ability to govern it wisely, guided by principles of fairness, safety, and human dignity.

¹¹ CyberLaw Consulting, AI and Data Privacy in India, https://www.cyberlawconsulting.com/ai_and_data_privacy_in_India.php (last visited May 4, 2025).

Green Energy Policies in India: A Critical Analysis of Legal Frameworks

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ABSTRACT

India's transition towards sustainable energy presents significant global benefits, as the country commits to achieving net-zero emissions by 2070. In pursuit of this goal, India aims to meet 50% of its electricity demand from renewable sources by 2030. The primary motivation behind this shift is not just to combat climate change, but also to ensure affordable, reliable, and environmentally friendly energy for its citizens, thereby fostering sustainable development. This strategic move is positioned as a critical turning point in the global efforts to address climate change.

Since the introduction of the National Action Plan on Climate Change (NAPCC) in 2008, India has positioned itself as a leader in renewable energy investment. A favourable investment climate, supported by progressive policies and programs, has attracted significant foreign direct investment (FDI). As a result, the renewable energy sector has not only made strides in meeting energy demands but also contributed to the creation of numerous jobs. One of the flagship programs, the National Solar Mission, under the NAPCC, seeks to enhance solar energy capacity, facilitating a gradual and sustainable transition towards renewable energy sources.

Despite these efforts, India's overall green energy share remains limited. Therefore, it is crucial to address the barriers hindering the growth of the renewable energy sector.

The sector, being part of the broader energy industry, is governed under the provisions of the Electricity Act, which encompasses generation, transmission, distribution, and trading of electricity. This paper aims to critically assess the significance of the renewable energy sector, its prospects, and the challenges it faces. Additionally, the paper will evaluate the effectiveness of current laws and emerging legal frameworks governing the green energy sector.

This analysis will serve as a valuable resource for stakeholders, including legislators, industry leaders, investors, and renewable energy producers, by providing insights into the current state of India's renewable energy policies and their growth potential. The paper also examines the broader implications of India's legal and policy frameworks in promoting green energy, comparing them with international best practices, and proposes solutions to overcome the challenges in implementing these policies.

Keywords: Green Energy, Renewable Energy, Climate Change, Legal Frameworks, Energy Transition, Foreign Direct Investment (FDI), Green Energy Challenges, Energy Sector Growth.

Introduction

Renewable energy offers a sustainable pathway for securing our future as we transition toward cleaner energy sources. It refers to energy derived from renewable resources such as sunlight, wind, and water, which play a significant role in reducing environmental pollutants. Unlike fossil fuels, which are major contributors to pollution, renewable energy sources are much cleaner and more environmentally friendly. Many nations recognise the urgency of shifting to renewable energy, as non-renewable resources are finite and cannot meet future demands¹.

India is one of the leading global producers of renewable energy and has been focusing on expanding its capacity. The country has implemented various laws and regulations

to encourage the development of renewable energy sources. India has been actively involved on the international stage in promoting renewable energy. One notable example is the International Solar Alliance (ISA), founded by India and France, which aims to advance solar energy across the world.

The world is now working towards creating new, clean, and renewable energy solutions for a more sustainable future. The growing challenges of energy consumption and environmental degradation underscore the importance of strong policies and governance in energy management. A transition to more effective energy systems requires coordinated efforts across all political levels, from local governments to international bodies.

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¹. Legha Mamta Ranjit Singh, Airemy Tanings, Aryan Tandon & Dev Chhillar, Critical Analysis of Emerging Green Energy Law; Forests and Livelihoods; Sustaining People and Planet, 12 IJ. ADV. RES. MGMT. & SOC. SCI. 41, 41 (May 2023), <https://garph.co.uk/IJARMSS/May2023/4.pdf>.

Currently, India generates approximately 150GW of renewable energy, with half of it coming from solar energy, cogeneration, and waste-to-energy projects; while the other half is sourced from small hydropower, biomass, and wind energy. By boosting its renewable energy capacity, India aims to enhance energy security, reduce environmental impacts, lower carbon emissions, and promote fair regional development. To support the growth of renewable energy, the Indian government has introduced various measures, including financial incentives, tax exemptions, and specific policies designed to promote clean energy. The Ministry of New and Renewable Energy (MNRE) oversees and drives these initiatives to meet the nation's renewable energy goals for the coming years.

Review of Literature

The global transition to renewable energy is a crucial step in addressing climate change and ensuring a sustainable future. Various reports and studies highlight the significance of green energy policies and the challenges countries face in promoting renewable energy. One such report, India Green Stimulus Report (NITI Aayog², June 2020), discusses how nations can use stimulus and recovery funds to not only rebuild their economies post-COVID-19 but also move towards a greener, fairer and sustainable future. It provides guidelines for utilising recovery funds in a way that benefits the environment and offers specific recommendations for countries like India, focusing on green investments as a critical part of recovery strategies. The report emphasises the need for countries to shift towards renewable energy to foster long-term economic resilience and environmental sustainability.

Another significant source is The Renewable Energy Law Review³, which outlines the legal frameworks governing renewable energy in India. The Electricity Act, 2003⁴, is the foundational legislation addressing renewable energy in the country. While the Act does not specifically define renewable energy, it has paved the way for various regulations that support its development, such as those by the Central Electricity Regulatory Commission (CERC). The review emphasizes India's legal commitment to renewable energy and suggests that the country must continue to enhance its regulatory frameworks to support a broader transition to cleaner energy sources.

An article from Drishti IAS titled Towards Green Energy Transition⁵ addresses the various challenges that India

faces in its journey towards a green energy transition. It discusses the hurdles related to technological innovation, financial constraints, and the need for greater policy support. The article also emphasizes the importance of global commitments, such as the Paris Agreement and other climate change mitigation instruments, where countries, including India, have pledged to achieve net-zero emissions. The article highlights the importance of collaboration between all stakeholders, including governments, industries, and civil society, to achieve these ambitious goals.

Collectively, these sources underscore the importance of renewable energy in India's future and the necessity of robust legal, financial, and policy measures to facilitate the green energy transition. The review of the literature reveals that, while they have made significant progress, India faces several challenges, including regulatory, financial, and technological barriers. Addressing these challenges will require continuous efforts and collaborative approaches, both domestically and globally, to achieve a sustainable and clean energy future.

Critically analysis of the Legal Framework that Governs Green Energy Policies in India, Focusing on Renewable Energy Sources

India's legal framework for renewable energy is multifaceted, encompassing a range of policies, regulations, and institutional mechanisms designed to promote the development and integration of renewable energy sources. The Electricity Act of 2003 serves as the cornerstone of India's energy legislation, providing a comprehensive framework for the generation, transmission, distribution, and trading of electricity. While the Act does not explicitly define renewable energy, it has helped to facilitate the growth of renewable energy through various provisions and subsequent regulations. The Central Electricity Regulatory Commission (CERC) has played a pivotal role by formulating specific regulations that support renewable energy integration into the national grid⁶.

Besides the Electricity Act, India has implemented several policies to bolster renewable energy development. The National Action Plan on Climate Change (NAPCC), launched in 2008, outlines India's strategy for addressing climate change, with a significant emphasis on promoting renewable energy. The Jawaharlal Nehru National Solar Mission (JNNSM), a key Component of NAPCC, aims to

². NITI Aayog, Energy, NITI AAYOG (Jan. 24, 2025), <https://www.niti.gov.in/verticals/energy>.

³. Renewable Energy Law and Policy Review, Edward Elgar Publishing Ltd., 11 RENEWABLE ENERGY LAW & POLY REV. 1-2 (2010-2023), ISSN 1869-4942, EISSN 2190-8265, <https://www.jstor.org/journal/reneenerlawpolre>.

⁴. The Electricity Act, 2003, No. 36 of 2003, Acts of Parliament, 2003 (India)

⁵. Drishti IAS, Towards Green Energy Transition, DRISHTI IAS (June 1, 2022), <https://www.drishtias.com/daily-news-editorials/towards-green-energy-transition>.

⁶. Dibyanshu & Prateek Bhandari, The Legal Framework for Renewable Energy in India, KHAITAN & CO., LEXOLOGY (Aug. 29, 2024), <https://www.lexology.com/library/detail.aspx?g=2dabb4b9-8cce-4d53-ae7c-0ab5dd3ac27e>.

establish India as a global leader in solar energy. The National Renewable Energy Act, 2015, was enacted to promote the production of energy from renewable sources, aiming to reduce dependence on fossil fuels and ensure energy security⁷.

Significance

India's energy future heavily relies on the adoption of green energy, which offers a sustainable solution to reduce dependence on depleting fossil fuels like coal and oil. This transition is crucial for ensuring energy security while addressing the increasing energy needs of a growing population. Renewable sources such as solar, wind, and hydropower provide a cleaner and more sustainable way to meet energy demands. By prioritising these resources, India can substantially cut down its carbon emissions, contribute to environmental preservation, and establish a robust energy system for the future.

The shift to renewable energy aligns with India's commitments under global climate agreements like the Paris Accord. The country aims to generate 50% of its electricity from renewable sources by 2030 and achieve net-zero emissions by 2070. This transition not only aids in achieving environmental goals but also promotes economic growth by attracting investments and creating employment opportunities in the green energy sector. With continued governmental support through policies and incentives, green energy stands at the forefront of India's sustainable development and its efforts to lead in addressing global climate challenges. The significance of green energy lies in its potential to revolutionise India's energy landscape by reducing dependency on non-renewable sources, such as coal and oil. This shift aligns with India's goal of achieving energy security while mitigating the adverse impacts of fossil fuel consumption on the environment. Green energy solutions, including solar, wind, and hydropower, offer a sustainable alternative that not only reduces carbon emissions but also addresses the growing energy demand of a rapidly developing economy. By harnessing renewable resources, India can transition towards a more resilient and environmentally friendly energy system, ensuring long-term energy security for its citizens. Green energy plays a crucial role in fulfilling India's international climate commitments under the Paris Agreement. With ambitious targets such as achieving 50% of electricity generation from renewable sources by 2030 and reaching net-zero emissions by 2070, green energy is integral to combating climate change. Beyond environmental benefits, it also

drives economic growth by attracting foreign investments, creating employment opportunities in the renewable energy sector, and promoting technological advancements. These factors collectively highlight the importance of green energy in shaping a sustainable future for India while contributing to global efforts to curb climate change.

Overview of Green Energy in India

Green energy refers to power generated from natural and renewable sources, such as sunlight, wind, water, and organic materials. These sources are sustainable and environmentally friendly, as they emit little to no greenhouse gases during energy production. Green energy got its name from the natural resources provided to us by the Earth. The colour green is often associated with health, nature and sustainability, so it makes sense that they relate renewable energy to the colour that embodies nature⁸.

The main green energy sources include:

a) Solar Energy - Solar energy⁹ is one of the most abundant energy resources available, capable of being harnessed even during cloudy days. The Earth receives solar energy at a rate approximately 10,000 times higher than the total energy consumed by humanity.

We can use this energy for a variety of purposes, including heating, cooling, lighting, electricity generation, and fuel production. Solar technologies work by converting sunlight into electrical energy, either through photovoltaic panels or using mirrors that focus solar radiation to generate power.

While the availability of solar energy varies across countries, every nation has the potential to incorporate solar power into its energy mix. Over the past decade, the cost of manufacturing solar panels has decreased significantly, making solar energy one of the most cost-effective electricity sources. Solar panels, with an average lifespan of about 30 years, are also available in different materials and shades to suit various needs and environments.

b) Wind Energy- Wind energy generates by capturing the kinetic energy of moving air through large wind turbines, which are installed on land (onshore) or over bodies of water, such as seas or lakes (offshore). While they have used wind energy for centuries, advancements in technology have significantly improved its efficiency. They designed modern turbines with taller structures and larger rotor blades to enhance electricity generation.

⁷. Dr. Prithvi Raj, Legal Framework Related to Renewable Energy in India - A Critical Study, GAP INTERDISCIPLINARITIES, Vol. V, Issue I, Jan.-Mar. 2022, at 27, [https://www.gapinterdisciplinarity.org/res/articles/\(27-32\)%20LEGAL%20FRAME%20WORK%20RELATED%20TO%20RENEWABLE%20ENERGY%20IN%20INDIA-%20A%20CRITICAL%20STUDY.pdf](https://www.gapinterdisciplinarity.org/res/articles/(27-32)%20LEGAL%20FRAME%20WORK%20RELATED%20TO%20RENEWABLE%20ENERGY%20IN%20INDIA-%20A%20CRITICAL%20STUDY.pdf).

⁸. Inspire Clean Energy Blog, <https://www.inspirecleanenergy.com/blog> (last visited Jan. 24, 2025).

Although wind speeds vary depending on location, the global potential for wind energy far surpasses the current global electricity demand. Many regions worldwide have sufficient wind resources to support large-scale wind energy projects.

While certain areas experience strong wind speeds, some of the most suitable sites for wind power generation are in remote regions. Offshore wind power, in particular, holds immense promise because of its ability to harness consistent and powerful wind resources over water¹⁰.

c) Hydroelectric power: Hydropower, also referred to as hydroelectric power, generates electricity by utilising the natural flow of water in rivers, streams, dams, or other water bodies. They can also harness it on a smaller scale, such as using water flow through household pipes, or natural processes like evaporation, rainfall, and ocean tides.

The environmental sustainability of hydropower depends on how it is developed and implemented. The degree to which it can be a truly "green" energy source varies based on factors like the scale of the project and its impact on ecosystems.

d) Biomass Energy: Biomass energy involves converting organic materials like agricultural waste, wood, and animal residues into usable energy. It is an efficient way to manage waste while generating power.

India's renewable energy potential :

India is uniquely positioned to harness renewable energy because of its geographical diversity. The country enjoys approximately 300 sunny days a year, providing immense potential for solar energy generation. India's vast coastline and strong wind corridors, particularly in states like Tamil Nadu, Gujarat, and Maharashtra, create ideal conditions for wind energy projects. Rivers and water bodies across the country support hydropower projects, while the abundance of agricultural and organic waste enables biomass energy development. India's energy landscape is rapidly transitioning towards renewable sources, emphasising sustainability and reducing reliance on fossil fuels. Over the past decade, India has made remarkable progress, setting ambitious targets like achieving 500 GW of non-fossil fuel energy capacity by 2030, announced at COP26. As of November 2024, the country's installed non-fossil fuel capacity has grown by 396% in 8.5 years, reaching over 205.52 GW, accounting for 42% of the total capacity. Solar energy has seen significant growth, with installed capacity rising from 2.5 GW in 2014 to 94.16

GW in 2024, driven by initiatives such as the International Solar Alliance.

The government has encouraged investments by permitting 100% FDI under the automatic route for renewable energy projects. Wind energy capacity has doubled since 2014 to 47.95 GW and is expected to reach 99.9 GW by 2030, with significant contributions from states like Gujarat, Rajasthan, and Maharashtra. Key initiatives like solar park development, SATAT for Compressed Bio-Gas (CBG) production, and provisions for rooftop solar installations under the 100 Smart City project show India's commitment to renewable energy. These efforts not only foster sustainability but also promise job creation and inclusive economic growth¹¹.

Current Renewable Energy Landscape

India has made remarkable progress in expanding its renewable energy capacity over the past decade. It is currently the world's fourth-largest producer of wind energy, with major installations in states such as Tamil Nadu and Gujarat. Solar energy has also seen significant growth, with large-scale solar parks and rooftop installations contributing to the country's energy mix. India had initially set a target of achieving 175 GW of renewable energy capacity by 2022, including 100 GW from solar energy, 60 GW from wind energy, and 15 GW from other sources like biomass and hydropower. The government has now revised its ambitions, aiming for 500 GW of renewable energy capacity by 2030.

National Goals and Commitments

India has shown strong commitment to addressing climate change through renewable energy initiatives. Under the Paris Agreement, the country pledged to reduce its carbon intensity by 33-35% by 2030 compared to 2005 levels. India aims to meet 50% of its energy needs from renewable sources by 2030 and achieve net-zero emissions by 2070. Policies such as the National Solar Mission and the development of green corridors for energy transmission reflect the government's proactive approach to promoting renewable energy. These efforts not only help mitigate climate change but also enhance energy security and create opportunities for economic growth through job creation and foreign investments.

India's renewable energy journey underscores its commitment to building a sustainable future while fulfilling its energy demands. With continued investments and policy support, the country is poised to become a global leader in green energy.

⁹. United Nations, What Is Renewable Energy?, <https://www.un.org/en/climatechange/what-is-renewable-energy> (last visited Jan. 24, 2025).

¹⁰. United Nations, What Is Renewable Energy?, <https://www.un.org/en/climatechange/what-is-renewable-energy> (last visited Jan. 24, 2025).

¹¹. Invest India, Renewable Energy, <https://www.investindia.gov.in/sector/renewable-energy> (last visited Jan. 24, 2025).

Legal framework governing green energy in India:

India has been reshaping the dynamics of its energy landscape by aggressively pursuing a set of legislative initiatives aimed at the propagation of renewable energy. In this way, besides encouraging the adoption of clean energy, the legislation also came up with a structured framework to ensure its proper growth and integration into the national grid. Let us understand the three key legislations that are changing the renewable energy domain in India.¹² India has established a comprehensive legal framework to promote the development and integration of green energy into its energy landscape. This framework encompasses constitutional provisions, key legislation, and regulatory bodies to ensure the efficient and sustainable utilisation of renewable energy resources.

Constitutional Provisions

The Indian Constitution emphasises environmental protection and sustainable development. Article 48A mandates the state to protect and improve the environment, ensuring the safeguarding of forests and wildlife. Similarly, Article 51A (g)¹³ highlights the fundamental duty of every citizen to protect and preserve the natural environment, emphasising the need for individual and collective responsibility toward sustainable practices.

Key Legislations

a) The Electricity Act, 2003: The Electricity Act, 2003, is a landmark piece of legislation aimed at regulating and advancing India's electricity sector. It serves as a foundational framework for various stakeholders, such as the central and state electricity regulatory commissions, to shape and drive renewable energy policies in the country.

- **Provisions for Renewable Energy** -The Act emphasizes the promotion of electricity generation from renewable energy sources. It mandates state governments to create policies that support grid connectivity and favourable tariff structures, thereby encouraging the adoption of renewable.
- **Roles of Stakeholders** -The Act clearly outlines the responsibilities of the central government, state governments, and regulatory bodies in fostering the growth of renewable energy projects. It includes setting targets for renewable energy adoption and ensuring their effective implementation, which provides a structured pathway for the sector's development.

- **Renewable Purchase Obligations (RPOs)** - A key feature of the Act is the introduction of Renewable Purchase Obligations (RPOs). This provision requires distribution companies to source a specific portion of their electricity from renewable energy sources, ensuring a consistent demand for clean energy and supporting its integration into the power grid.

Significance of the Act - The Electricity Act, 2003, creates a unified framework for incorporating renewable energy into India's power system. It establishes a stable and transparent environment, fostering investor confidence and encouraging the development of sustainable energy projects across the country.¹⁴

b) The Energy Conservation Act, 2001 - The Energy Conservation Act (EC Act) was enacted in 2001 to reduce the energy intensity of India's economy. The Bureau of Energy Efficiency (BEE), established in 2002, was set up to implement the Act. Key provisions of the Act include:

- Standards and labelling for equipment and appliances.
- Energy conservation building codes for commercial buildings.
- Energy consumption norms for energy-intensive industries.

The Act also mandates the central government and BEE to promote energy efficiency across various sectors and requires states to establish agencies for implementation at the local level. In 2010, it amended the Act to introduce Energy Savings Certificates (Escerts). They gave these certificates to consumers who consume less energy than prescribed, while those who exceed the norms must purchase certificates to meet the standards. The Act also brought commercial buildings with significant energy demand (above 100 kW load or 120 kVA contract demand) under the Energy Conservation Building Code (ECBC).

Through various initiatives, such as household lighting improvements, energy efficiency in commercial buildings, and demand-side management, the Ministry of Power and BEE achieved significant energy savings, with a target of 10,000 MW of avoided generation capacity during the XI Plan period, surpassing the target with 10,836 MW of avoided capacity generation¹⁵.

The Bureau of Energy Efficiency (BEE) was established on 1st March 2002 under the Energy Conservation Act, 2001, to help India reduce its energy intensity. The primary

¹². Legal Framework for Renewable Energy in India, FreeLaw (July 5, 2024), <https://www.freelaw.in/legalarticles/Legal-Framework-for-Renewable-Energy-in-India>.

¹³. Constitution Subarticle, Article 51A(g), Constitution of India, Indian Kanoon, <https://indiankanoon.org/doc/1644544/>.

¹⁴. Legal Framework for Renewable Energy in India, FreeLaw (July 5, 2024), <https://www.freelaw.in/legalarticles/Legal-Framework-for-Renewable-Energy-in-India>.

¹⁵. Energy Conservation Act, International Energy Agency (Nov. 9, 2023), <https://www.iea.org/policies/1975-energy-conservation-act>.

mission of BEE is to develop policies and strategies that focus on self-regulation and market-based approaches, aligning with the objectives of the Energy Conservation Act, 2001.

Vision - The vision of BEE is to enhance the energy efficiency of India's economy, contributing to the country's sustainable development.

Mission - BEE's mission is to create policies and strategies for energy conservation, emphasizing self-regulation and market principles, within the framework of the Energy Conservation Act, 2001. The goal is to lower the energy intensity of the Indian economy by fostering broad participation from all sectors, which will encourage long-term energy efficiency adoption.

Objectives and Strategies - The main goal of BEE is to reduce the energy intensity of India's economy. To achieve this, the BEE employs several key strategies:

- **Policy Development:** Creating policies and programs that promote energy efficiency and conservation, involving relevant stakeholders.
- **Program Implementation:** Planning and executing energy conservation initiatives in line with the Energy Conservation Act.
- **Leadership and Direction:** Leading the national efforts on energy efficiency and providing the policy framework.
- **Public-Private Partnerships:** Demonstrating energy efficiency mechanisms through collaborations between the public and private sectors.
- **Monitoring and Verification:** Establishing systems to measure and verify energy efficiency outcomes across sectors and at a national level.
- **Leveraging Support:** Securing funding and support from multilateral, bilateral, and private sector sources to implement energy-efficient projects.
- **Awareness Campaigns:** Promoting awareness around energy savings and conservation to encourage broader participation¹⁶.

c) National Solar Mission (2010) - Part of the National Action Plan on Climate Change (NAPCC), the National Solar Mission aims to position India as a global leader in solar energy. Its ambitious target of achieving 100 GW of solar energy capacity by 2022 underscores India's commitment to harnessing its abundant solar potential. The Jawaharlal Nehru National Solar Mission (JNNSM),

launched in January 2010, aims to make India a global leader in solar energy. It seeks to promote sustainable growth, address energy security, and contribute to global climate change efforts. The mission follows a three-phase approach, targeting 20,000 MW of grid-connected and 2,000 MW of off-grid solar capacity by 2022. The revised target for grid-connected solar projects is 100,000 MW by 2022.

To achieve this, the mission focuses on creating an enabling policy framework, large-scale deployment, research and development, and domestic production of solar components. The goal is to reduce solar energy costs, achieving grid parity by 2022 and parity with coal by 2030. The mission also prioritises improving solar efficiency, reducing system costs, and addressing storage challenges.

Phase I focused on off-grid systems and modest capacity additions, while Phase II aims to ramp up capacity and improve solar energy penetration. The development of solar parks and transmission networks will help reduce costs and enhance market competition. Beyond grid power, the mission is transforming India's rural economy, with decentralised solar applications like lighting systems and water pumps improving access to energy for millions.

Solar energy is eco-friendly and abundant, especially in India, which receives strong sunlight year-round. The National Action Plan on Climate Change highlights India's potential for solar power, emphasizing its role in decentralized energy distribution and empowering local communities¹⁷.

Major Positive Developments Since 2014

1. The Government, as per its ambition to provide electricity for all, revised the target for establishing grid-connected solar power from 20 GW to 100 GW under the National Solar Mission (NSM).
2. The huge quantum jump in targets generated huge demands for solar energy projects and equipment.
3. They divided 100 GW into two major segments: a) 60 GW of grid-connected ground-mounted large solar power plants, typically above 1 MW capacity. b) 40 GW of rooftop solar power plants for the generation of electricity.
4. Emphasised to rope in Central and State Public Sector companies, defence establishments, and others who started establishing projects on their unexploited land. To avoid the problem of limited land availability, innovative ideas such as floating solar power plants, solar power plants over canals,

¹⁶. Bureau of Energy Efficiency, BEE India, <https://beeindia.gov.in/en/about-bee>.

¹⁷. Jawaharlal Nehru National Solar Mission, India Science and Technology, <https://www.indiascienceandtechnology.gov.in/st-visions/national-mission/jawaharlal-nehru-national-solar-mission-jnnsnm>.

use of barren land for solar power plants are being promoted.

5. Revised targets for Renewable Purchase Obligations (RPO), to ease the purchase of solar power, net metering, and interstate power purchase by bulk consumers such as the Delhi Metro.
6. Focus on skill development and indigenous manufacturing through the establishment of the Skill Council for green jobs¹⁸.

India's Vision 2030 - India's Vision 2030 focuses on becoming a leader in renewable energy and addressing climate change through green growth. With the Panchamrit Policy at its core, India has set ambitious targets:

- Achieve 500 GW of renewable energy capacity by 2030
- Source 50% of its energy from renewable by 2030
- Cut projected carbon emissions by 1 billion tons by 2030
- Reduce carbon intensity by 45% by 2030
- Reach net-zero emissions by 2070

By 2047, India aims for energy independence, using electric mobility, CNG, ethanol blending, and green hydrogen, aiming for 90% renewable energy. Achieving these goals requires annual investments of \$350-400 billion and could create 5-6 million jobs by 2030.

Solar power plays a crucial role in this transition, offering environmental benefits such as reducing carbon footprints, pollution, and supporting a sustainable future. As India pursues its solar targets, investors have opportunities in solar projects and manufacturing, with a supportive policy ecosystem and government backing. India's solar journey offers a chance for global investors to contribute to a cleaner, greener future¹⁹.

National Wind-Solar Hybrid Policy

The National Wind-Solar Hybrid Policy was launched on 14th May 2018 to promote large grid-connected wind-solar hybrid systems for optimal use of resources, land, and transmission infrastructure. The policy encourages the combined operation of wind and solar plants, with a focus on new technologies and methods.

Key features of the policy include:

- **Integration:** For fixed-speed wind turbines, integration occurs at the AC output bus, while variable-speed turbines can integrate with the DC bus.
- **Sizing:** A wind-solar plant is a hybrid if the capacity of one resource is at least 25% of the other.
- **Existing Projects:** Existing wind or solar plants can add the other resource to become a hybrid.
- **Battery Storage:** It can add battery storage to reduce output variability, increase energy output, and ensure power availability.
- **Tenders:** Agencies like SECI, NTPC, SJVN, and NHPC have issued tenders for solar-wind hybrid projects, with about 1.44 GW of hybrid projects already commissioned by December 2023²⁰.

Advantages of Hybrid Renewable Energy

Environmental Benefits - In terms of the environment, hybrid renewable energy systems are game-changers. They reduce the carbon footprint from conventional energy production by tapping into nature's unlimited supply of renewable resources. But switching to cleaner sources makes energy sustainable, and we remain at the front line in the global fight against climate change.

Economic Advantages - Such systems optimise energy use, resulting in considerable cost savings. By lessening one's dependence on fossil fuels, with prices that seem to swing up and down with little warning, it is easy for businesses and consumers to enjoy more reliable and manageable energy budgets. It is this kind of financial efficiency that makes hybrid systems increasingly preferred for long-term investment energy solutions.

Reliability and Resilience - Other than the green and cost-effective ideas, hybrid renewable energy systems portray reliability and resilience. They ensure a constant power supply, critical in areas where varied environmental conditions prevail. In such systems, multiple energy sources can keep power even when one is less effective; hence, irrespective of weather or time of day, the energy output remains stable and reliable. That's the resiliency needed to back an energy infrastructure that can take the forces the changing climate puts on it²¹.

The Environment Protection Act, 1986

The Environment Protection Act, 1986 (EPA) is a key environmental law in India, aimed at preserving and

¹⁸. National Solar Mission, BYJU'S Free IAS Prep, <https://byjus.com/free-ias-prep/national-solar-mission/>.

¹⁹. Invest India, India's Solar Power Revolution: Leading the Way in Renewable Energy, Invest India, Nov. 6, 2023, <https://www.investindia.gov.in/blogs/indias-solar-power-revolution-leading-way-renewable-energy>.

²⁰. Alok Mishra & Dheep Joy Mampilly, Promotion of Large Grid-Connected Wind-Solar PV Hybrid System Under National Wind-Solar Hybrid Policy: 1.44 GW Wind-Solar Hybrid Capacity Has Been Commissioned, Press Information Bureau, Feb. 8, 2024, <https://pib.gov.in/PressReleasePage.aspx?PRID=1717287>.

²¹. Sudhir Pathak, Hybrid Renewable Energy: Paving the Way for a Greener Tomorrow, Hero Future Energies, Oct. 8, 2024, <https://www.herofutureenergies.com/blog/hybrid-renewable-energy/>.

improving the environment. It merges various existing laws and creates a framework for addressing environmental challenges across the country.

Historical Background - Before the EPA, multiple laws such as the Indian Penal Code and the Air and Water Pollution Acts were in place, but lacked a unified approach. After the 1972 Stockholm Conference, comprehensive law is in need. India's Constitution, through the 42nd Amendment (1976), made environmental protection a responsibility of the State and citizens, setting the stage for the EPA.

Objectives of EPA - Create authorities with the power to protect the environment. Coordinate activities of various regulatory bodies. Regulate pollutants and hazardous substances. Ensure swift action in case of environmental accidents and impose deterrent punishments.

Key Features-

- The Act empowers the Central Government to set national environmental standards, regulate industrial locations, and control pollution.
- It allows agencies like the Central Pollution Control Board²⁰ (CPCB) and state bodies to implement its provisions.
- Penalties for non-compliance include fines up to Rs. 1 lakh and imprisonment for up to 5 years.

Challenges and Effectiveness - While the Act gives the government broad powers, environmental issues like pollution and inefficient waste management persist. The government's failure to provide adequate information and enforce the Act has led to continued environmental damage. However, the Act allows the public to file complaints, which is a unique feature for enforcement.

The Environment Protection Amendment Rules, 2021, aim to decriminalise certain violations by replacing imprisonment with higher fines, ranging from Rs. 5 lakh to Rs. 5 crore, depending on the severity. It will still prosecute serious violations resulting in injury or death under the Indian Penal Code. Penalties will contribute to an Environmental Protection Fund, and it will appoint an adjudication officer to decide penalties. Governments need to strengthen enforcement with clear guidelines and promote sustainable practices like Reduce, Reuse and Recycle. It should take strict action against those who cannot comply with environmental protection measures²³.

Statutory Bodies in India's Renewable Energy Sector

India has several regulatory bodies that oversee and

promote the development of renewable energy. These bodies are involved in policy-making, regulating tariffs, and facilitating renewable energy projects.

Ministry of New and Renewable Energy (MNRE)

- **Policy Formulation:** MNRE creates policies to encourage renewable energy, attract investment, and make project clearances easier.
- **Implementation:** It oversees the implementation of renewable energy programs and works with various government bodies and the private sector.
- **Incentives and Subsidies:** MNRE offers financial incentives like subsidies, grants, and tax benefits to reduce costs for developers.
- **Research and Development:** It funds research and works with institutions to develop and improve renewable energy technologies.

Central Electricity Regulatory Commission (CERC)

- **Tariff Regulation:** CERC sets competitive tariffs for renewable energy, making it attractive for investors.
- **Integration of Renewable Energy:** CERC develops frameworks for connecting renewable energy to the national grid.
- **Market Development:** It promotes markets like Renewable Energy Certificates and power purchase agreements.
- **Dispute Resolution:** CERC mediates disputes between electricity sector stakeholders.

State Regulatory Commissions

- **Regulatory Oversight:** State commissions adopt national renewable energy policies to local needs and ensure compliance.
- **Tariff Setting:** They set renewable energy tariffs specific to their state, taking local factors into account.
- **Project Facilitation:** State bodies help facilitate the setup of renewable energy projects by issuing clearances and addressing local issues.
- **Monitoring and Compliance:** They monitor renewable energy projects and ensure that state and national regulations are followed.

These bodies work together to ensure that renewable energy projects grow smoothly and efficiently in India²⁴.

²². Central Pollution Control Board, Official Website, INDIA.GOV.IN, <https://www.india.gov.in/official-website-central-pollution-control-board>.

²³. NEXT IAS Team, Environment Protection Act, 1986 (EPA, 1986), NEXT IAS, Aug. 30, 2024, <https://www.nextias.com/blog/environment-protection-act-1986/>.

²⁴. Dibyanshu & Prateek Bhandari, Legal Framework for Renewable Energy in India, FREELAW.IN (July 5, 2024), <https://www.freelaw.in/legalarticles/Legal-Framework-for-Renewable-Energy-in-India>.

Challenges in Implementing Green Energy Policies

The renewable energy industry faces many obstacles, including political challenges, inconsistent government policies, corporate interests, outdated infrastructure, inadequate battery storage solutions, and the current state of the energy market. These factors create hurdles for its widespread adoption on a global scale.

However, despite these challenges, renewable energy is steadily gaining traction worldwide as a vital tool to combat climate change. It offers a clean energy alternative, free from direct pollution and carbon emissions, making it a practical and sustainable substitute for fossil fuels. Over time, renewable energy has become an essential component of the global energy mix, paving the way for a cleaner and greener future²⁵.

Key Challenges in the Renewable Energy Industry

Technological Challenges:-

- **Unpredictability**

Renewable energy sources like solar and wind depend highly on weather, resulting in inconsistent energy production. This variability poses challenges for maintaining a reliable energy supply. The key issue is ensuring a stable energy flow despite these fluctuations.

- **Energy storage challenges**

To address the unpredictability of renewable energy, efficient energy storage solutions are crucial. However, current battery technologies face limitations in capacity and durability, making it difficult to scale their use. Developing advanced storage systems is essential for balancing energy supply with demand.

- **Grid Integration Difficulties**

Integrating Renewable energy into existing power grids presents significant challenges. Compatibility issues can disrupt grid stability and security. To manage this, upgrading the grid infrastructure to handle increased contributions from renewable sources is critical.

Financial Challenges:-

- **High Costs**

Renewable energy projects often require substantial upfront investments for the installation of solar panels, wind turbines, and related infrastructure. These high costs can act as a barrier to adoption. Securing sufficient funding and implementing financial incentives are necessary to address this challenge.

- **Market Competition**

The renewable energy sector competes with well-established fossil fuel industries. Price fluctuations in fossil fuels can reduce the competitiveness of renewable options. Shifts in market demand and supply dynamics can influence the sector's growth and adoption rates²⁶.

Challenges in Policies and Regulations:-

- **Inconsistent Regulatory Frameworks** - Energy policies vary significantly across different regions, leading to a lack of uniformity and coherence. These inconsistencies can create confusion, discourage investments, and slow down the progress of renewable energy projects. The absence of well-defined long-term policies can hinder the industry's ability to plan and grow effectively.

- **Regulatory Barriers** - Securing the permits and licenses for renewable energy projects can be a lengthy and complicated process. Regulatory challenges, such as obtaining approvals for grid connections, can delay or obstruct the implementation of projects, making it harder for new initiatives to take off.

Community and Environmental Challenges:-

- **Resistance from Communities (NIMBY Syndrome)** - Local opposition, often referred to as the "Not in My Backyard" (NIMBY) phenomenon, can significantly slow down renewable energy projects. Many communities resist these developments because of misunderstandings about their environmental or economic impacts, leading to delays or project cancellations.

- **Environmental Impacts** - Although renewable energy is eco-friendly, large-scale projects can have negative environmental consequences. For instance, the construction of wind or solar farms may disrupt local ecosystems and wildlife habitats. The extraction of raw materials required for renewable energy technologies can raise environmental and sustainability concerns.

Land Use and Environmental Issues:-

The large-scale establishment of renewable energy infrastructure can sometimes result in conflicts over land use and raise environmental concerns. For example, hydropower projects have the potential to alter natural water flow, which can negatively affect aquatic ecosystems. To address these challenges, it is crucial to conduct comprehensive environmental impact assessments and involve all stakeholders in minimising negative effects.

²⁵. Regen Power, What Are the Problems Faced by Renewable Energy?, REGEN POWER, Articles, Solar System, <https://regenpower.com/what-are-the-problems-faced-by-renewable-energy/> (last visited Jan. 25, 2025).

²⁶. Sudhir Pathak, The Challenges and Solutions in Scaling up Renewable Energy, HERO FUTURE ENERGIES (Oct. 8, 2024), <https://www.herofutureenergies.com/blog/renewable-energy-challenges-and-solution/> (last visited Jan. 25, 2025).

Policy and Regulatory Challenges:-

The development of renewable energy depends significantly on well-designed policy and regulatory frameworks. However, inconsistent or insufficient policies can impede progress in the renewable energy sector. To foster growth, governments should introduce clear, stable, and long-term strategies, such as providing financial incentives and subsidies, to encourage the widespread adoption of renewable energy technologies²⁷.

Public Awareness and Participation

Another major barrier to the adoption of renewable energy is the lack of public awareness. They do not inform many people about the environmental and economic benefits of renewable energy. Without proper awareness, there is limited public participation and support for renewable energy initiatives. Educating the public about the positive impact of renewable energy on climate change, energy security, and local economies is essential for increasing adoption and creating a more sustainable energy future.

Comparative Analysis: India And Global Practices

In addressing these challenges, India can learn valuable lessons from other countries that have made significant progress in renewable energy adoption. Countries like the European Union (EU), China, and the United States have developed policies and practices that can serve as models for India.

European Union (EU) The European Union has pledged to reduce greenhouse gas emissions by 40% by 2030. A central policy for achieving this goal is the Renewable Energy Directive (RED), introduced in 2009. The directive set a target for EU nations to ensure that 20% of their total energy consumption comes from renewable sources by 2020.

Bio fuels, derived from plants, offer a renewable and low-carbon substitute for fossil fuels, particularly in transportation. However, their use poses several social, economic, and environmental challenges, such as threats to food security, loss of biodiversity, and conflicts over land use. Without proper safeguards, bio fuel production could displace agricultural activities for food and lead to ecosystem damage, potentially offsetting the intended reduction in greenhouse gas emissions.

The RED, created in 2009, was aimed at supporting EU countries in achieving their renewable energy objectives. It includes provisions to ensure that bio fuels consumed in the EU are produced sustainably and in an environmentally responsible manner. To meet these goals,

the directive outlined specific sustainability criteria. The policy underwent revisions following public consultations in 2013 and 2017. The updated versions expanded its scope to include sustainability standards for wood and other biomass, further aligning with broader environmental objectives²⁸.

China - China has become the largest producer of renewable energy in the world by heavily investing in the sector. The Chinese government provides strong support for renewable energy development through subsidies, tax incentives, and favourable policies for domestic manufacturers. China also encourages foreign investment in renewable energy technologies, helping to make renewable energy more affordable and accessible. India can draw inspiration from China's large-scale investments and create an environment conducive to attracting both domestic and international investors.

United States - The United States has successfully boosted its renewable energy sector through the use of tax credits such as the Production Tax Credit (PTC) and the Investment Tax Credit (ITC). These incentives provide financial support to renewable energy projects, making them more economically viable. The U.S. government also promotes research and development in renewable energy technologies, driving innovation in the sector. India can benefit from implementing similar financial incentives and investing in renewable energy research to improve the cost-effectiveness and efficiency of renewable technologies.

Comparative Insights for India

India can learn several lessons from the renewable energy practices of other countries. First, establishing a clear and unified policy framework at both the national and state levels can help reduce confusion and create a conducive environment for investment. Second, offering more financial incentives, such as tax credits and subsidies, can encourage private investment in renewable energy projects. Third, creating stronger public-private partnerships can help speed up project implementation and improve grid integration. Finally, investing in research and development can lead to innovations that make renewable energy technologies more cost-effective and reliable.

By adopting some of these global best practices, India can overcome its renewable energy challenges and make significant progress toward its clean energy goals.

²⁷. Shalin Sheth, Green Energy Transition: Opportunities and Challenges for Sustainable Power Generation, CXOTODAY (authored by Founder & Managing Director, Advait Infratech), <https://cxotoday.com/specials/green-energy-transition-opportunities-and-challenges-for-sustainable-power-generation/> (last visited Jan. 25, 2025).

²⁸. ISEAL Alliance, Private Sustainability Standards and EU Renewable Energy, <https://www.isealliance.org/impacts-and-benefits/case-studies/private-sustainability-standards-and-eu-renewable-energy> (last visited Jan. 25, 2025).

Recommendations for Strengthening Green Energy Legal Framework

Globalisation has intensified competition among nations for dominance in political, economic, and commercial spheres. This surge in commercial activities and urbanisation has significantly increased the demand for energy, particularly electricity. To address these growing energy needs while reducing environmental impact, many countries have turned to renewable energy sources like solar, wind, hydro, biomass, and waste-to-energy²⁹.

India has made remarkable progress in the renewable energy sector. In 2021, the country achieved a major milestone by fulfilling one of its Paris Agreement 2030 Nationally Determined Contributions (NDC) commitments nine years ahead of schedule. By November 2021, India had exceeded its target to achieve 40% installed capacity from non-fossil sources. On August 12, 2021, India surpassed the 100 GW installed renewable energy capacity mark (excluding large hydro projects). Globally, India ranks fourth in terms of overall installed renewable energy capacity. As of December 31, 2021, the nation's renewable energy capacity reached 104.88 GW and grew to over 174.53 GW, including large hydro, by February 2023.

The Indian power sector operates under the framework of the Electricity Act, 2003, which provides regulations for the generation, transmission, distribution, and trading of electricity, including renewable energy. The act empowers the Commission to determine tariffs for renewable energy sources. The Ministry of New and Renewable Energy (MNRE) acts as the primary authority responsible for promoting and developing renewable energy in the country.

Schemes for the Renewable Energy Sector:-

- To support the renewable energy sector, the Indian government, in collaboration with MNRE and organizations like the Solar Energy Corporation of India (SECI)³⁰, has implemented various initiatives. These include the development of Solar Parks and Ultra Mega Solar Power Project aimed at creating essential infrastructure, such as land, power evacuation systems, and road connectivity to facilitate renewable energy growth. The Solar Parks Scheme is being implemented with a target of achieving a 40 GW capacity by March 2024. These efforts reflect India's commitment to speeding up the transition to cleaner energy and fostering sustainable development.

- Before the onset of the COVID-19 pandemic, the Indian government introduced several subsidy programs aimed at promoting sustainable energy initiatives. Among them were the PM KUSUM scheme (Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan) and Phase II of the FAME India scheme (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India).

- The PM KUSUM scheme was designed specifically for farmers, with the goal of ensuring energy and water security in agriculture. It focuses on reducing the reliance on diesel in the farming sector while also enabling farmers to generate additional income by producing solar power. This initiative not only supports sustainable agriculture but also contributes to the broader goal of expanding renewable energy use in rural areas.

- On September 30, 2022, the Ministry of New & Renewable Energy introduced guidelines for the implementing the Production Linked Incentive (PLI) Scheme's second phase under the 'National Programme on High-Efficiency Solar PV Modules.' This phase has a financial allocation of ₹19,500 crore and aims to establish approximately 65 GW of fully or partially integrated solar PV manufacturing capacity.

- To achieve its target of 500 GW of installed electricity capacity from non-fossil sources by 2030, the Government of India, in collaboration with various ministries, has been actively working to strengthen and expand renewable energy infrastructure. They have introduced several initiatives including schemes for solar rooftops, off-grid solar systems, the green energy corridor, production-linked incentives, and programs for wind and bio energy development. These efforts reflect the government's commitment to transitioning to sustainable energy sources and reducing carbon emissions.

Public Awareness Campaigns

Governments and organizations should prioritize educating the public on the advantages of renewable energy to foster greater participation in green initiatives. Effective public awareness campaigns can inform citizens about the economic and environmental benefits of renewable energy, leading to increased adoption and support for sustainable practices. For instance, the United Nations emphasizes that education is a critical agent in addressing climate change, assigning responsibility to parties of the UN Framework Convention on Climate Change to undertake educational and public awareness campaigns on climate change³¹.

²⁹. Rajdutt Shekhar Singh & Swekcha Singh, How the Legal Framework Can Be Modified to Facilitate the Expansion of the Renewable Energy Industry, ET CONTRIBUTORS (May 5, 2023), <https://economictimes.indiatimes.com/small-biz/sme-sector/how-the-legal-framework-can-be-modified-to-facilitate-the-expansion-of-the-renewable-energy-industry/articleshow/100003716.cms?from=mdr>.

³⁰. Solar Energy Corporation of India, <https://www.seci.co.in/>

³¹. United Nations, Education: A Key to Addressing Climate Change, <https://www.un.org/en/climatechange/climate-solutions/education-key-addressing-climate-change>.

The Bureau of Energy Efficiency (BEE)³² has launched several initiatives to raise public awareness about energy conservation through various media channels. These campaigns aim to educate the public on energy-efficient practices and the importance of energy conservation.

Print Media: BEE uses print advertisements in newspapers to inform the public about the star ratings of electric appliances, helping people make more informed choices. BEE promotes the National Energy Conservation Awards (NECA)³³ through national advertisements, recognizing industries, institutions, and sectors that excel in energy conservation. This recognition motivates others to adopt similar practices.

Electronic Media: BEE sponsors the radio program "Bachat Ke Sitare - Dost Humare"³⁴ which airs on All India Radio (FM GOLD and FM RAINBOW) in 19 languages. The 15-minute episodes combine energy conservation messages with entertainment, making the information more engaging and memorable for a broader audience.

Social Media: BEE actively engages with the public through various social media platforms as Facebook, Twitter, LinkedIn, Instagram, and YouTube. These platforms allow BEE to communicate directly with people, share updates, and encourage participation in energy-saving initiatives.

Outdoor Media: BEE takes part in exhibitions across the country to showcase its energy conservation schemes and engage with both industry professionals and the public. Interactive displays, demonstrations of energy-efficient appliances, and engagement activities like quizzes and games at these events to spread awareness interactively.

School Awareness Programs: As part of its efforts to build awareness from an early age, BEE has collaborated with the Ministry of Power to introduce energy conservation topics in school curricula. This includes creating educational materials for students and organizing activities such as debates, quizzes, and the establishment of Energy Clubs in schools. These programs aim to equip students with knowledge about energy efficiency, encouraging them to practice and promote energy conservation in their daily lives.

Promotional Materials: BEE regularly publishes documents and reports like the BEE Line and Annual Reports, which are distributed to stakeholders and made available on their website for wider public access.

These combined efforts aim to build a culture of energy

conservation across India, encouraging active public participation in creating a more energy-efficient nation.

Conclusion

India's renewable energy sector has made remarkable progress³⁵ in recent years, positioning it as a key player in global efforts to combat climate change and promote sustainable energy. Through a combination of ambitious policies, strategic investments, and an unwavering commitment to renewable energy development, India has achieved significant milestones. Notably, the country surpassed its 2030 target of generating 40% of its electricity from renewable sources by achieving this goal early in 2022. This accomplishment reflects the nation's resolve to transition towards greener, more sustainable energy solutions.

However, India's renewable energy journey is far from complete. Despite these successes, the sector continues to face challenges related to policy coherence, financial constraints, land acquisition issues, and integrating renewable energy into the existing grid infrastructure. Strengthening inter-agency collaboration between state and central governments, along with a more transparent and supportive financial framework, will be crucial in addressing these hurdles. Innovations in energy storage, hydrogen, and electric vehicles could play a vital role in expanding the renewable energy capacity, while fostering economic growth and job creation.

India's renewable energy potential remains vast, with about 1096 GW of untapped resources. To fully harness this potential, the government has introduced several key initiatives, including the National Solar Mission, PM KUSUM, Green Energy Corridor and various incentives schemes for solar and wind energy. These efforts, alongside private sector participation and public-private partnerships, will help to achieve India's long-term energy and environmental goals.

In conclusion, while India has made significant strides in scaling up renewable energy, much remains to be done to ensure that renewable become the dominant source of energy in the country. A cohesive, harmonized policy framework, along with robust investments in technology and infrastructure, is essential for realizing India's ambitious renewable energy targets. India is on the path to becoming a global leader in clean energy, and with sustained commitment, innovation, and international collaboration, it can achieve a sustainable, energy-secure future that benefits both its citizens and the planet.

³². Bureau of Energy Efficiency, <https://beeindia.gov.in/en>

³³. National Energy Conservation Award, Bureau of Energy Efficiency, <https://neca.beeindia.gov.in/>

³⁴. Bureau of Energy Efficiency, Bachat ke Sitare Magazine, <https://beeindia.gov.in/sites/default/files/publications/files/Bachat%20ke%20Sitare%20Magazine%20%285%29.PDF>

³⁵. Ministry of New and Renewable Energy, Ministry of New and Renewable Energy (2025), <https://mnre.gov.in>.

Critical Study on Maritime Autonomous Vessels and their compliance with International War Laws

I.P. Mithu¹

ABSTRACT

Humanity exhibits a constant drive to develop new technologies. The benefits of technological innovation are substantial. However, these technologies pose a significant threat when they are designed to perform tasks originally undertaken by humans, particularly through machine learning. Such advancements are capable of operating in hazardous environments where human presence is not feasible. Paradoxically, rather than reducing casualties, these technologies have increased complexities. Existing legal frameworks struggle to keep pace with these advancements, as the societal liabilities they introduce are unimaginable. States are increasingly inclined to utilize these technologies for scientific research and military operations. The trend of states with significant military and naval capabilities continues to rise in international arena. Although human resources have been diminishing in various sectors due to these technologies, a particularly concerning area is warfare. There is a long history of states dominating oceans through naval technologies and submarines. Sea dominance gives nations a significant strategic advantage, shaping global trade and defence mechanisms. Naval warfare is undergoing a tremendous shift, propelled by cutting-edge technologies and strategic advancements. From traditional warships to autonomous vessels, these innovations are redefining maritime defence operations and capabilities. The deployment of autonomous vessels at sea allows for self-regulation during operations². This paper examines the concept of autonomous vessels, the role of International Maritime Organization (IMO) in regulating these vessels, the emerging complexities associated with their use in naval warfare, and the extent to which they comply with international laws of war and humanitarian laws.

Keywords: Military technology, Warfare technology, Naval warfare, Autonomous vessels, Maritime defence, International Maritime Organization (IMO), Maritime regulation

Changing Definition of Vessels

The United Nations Convention on the Law of the Sea (UNCLOS)³ does not explicitly defined the terms "vessel" or "ship", which places primary importance; however, Articles 19⁴, Article 20⁵, and Article 94 implicitly address unmanned vessels. Article 94 of UNCLOS assigns responsibility to flag states to ensure the safety of vessels, which includes the requirement for properly manned crew members. UNCLOS does not explicitly defined government ships and what constitutes non-commercial service, though the term is often associated with auxiliary vessels. According to the San Remo Manual and UK definitions, auxiliary vessels refer to non-warship vessels

that are either owned or controlled by a state's armed forces and temporarily used for government non-commercial purposes. These vessels are under sovereign immunity which is similar to warships. In the UK Royal Navy, autonomous vessels currently under trial are classified as government ships on non-commercial service, allowing them to claim sovereign immunity and navigational rights.

Article 11b of the International Convention on Salvage⁶, Regulation V/2 of the International Convention for the Safety of Life at Sea 1974 (SOLAS)⁷, Article 2 of the Convention for the Prevention of Pollution from Ships (MARPOL)⁸, Rule 3 of The International Regulations for

¹. Student, LLM Maritime Law (2023- 2025) at The Tamil Nadu Dr. Ambedkar Law University, Chennai.

². Autonomous Ships Market, Autonomous Ships Market Analysis Report | 2020 - 2030, <https://www.nextmsc.com/report/autonomous-ships-market>, Accessed on 12 May 2025.

³. United Nations Convention on the Law of the Sea opened for signature Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 16, 1994).

⁴. Ships engaged in innocent passage are restricted from deploying, recovering, or receiving military assets, which include unmanned aerial vehicles (UAVs) and unmanned maritime systems (UMSs).

⁵. Submarines and other underwater vehicles must surface and visibly display their national flag while passing through a territorial sea under the principle of innocent passage.

⁶. A vessel refers to any ship, craft, or any structure capable of navigation.

⁷. Any ship, vessel, or craft, irrespective of type and purpose.

⁸. A vessel of any type that operates in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, and fixed or floating platforms.

Preventing Collisions at Sea 1972 (COLREG)⁹, and Article 1 of the Convention on the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA)¹⁰ provide definitions for the term "vessel". These definitions, along with those from various state legislatures, primarily describe the physical structure of ships, with manning being an essential feature. The Maritime Labour Convention (MLC), 2006, and The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW), 1978, are the principal documents governing the manning of vessels with qualified crew members and their regulations. The International Safety Management Code (ISM Code) mandates ship operators to implement Safety Management Systems and enhance safe operations, environmental protection, emergency response, and communication between ships and shore personnel. Compliance ensures legal seaworthiness, while violations could lead to litigation risks. As autonomous shipping evolves, developing standardized legal framework and ensuring harmonization of safety standards will be crucial for effective governance of international maritime security. The increasing role of automation necessitates regulatory adaptation, ensuring efficiency while maintaining safety and compliance in global maritime operations. The 1969 Vienna Convention on the Law of Treaties (VCLT)¹¹ sets the general principles for interpreting treaties that provisions should be understood in good faith. Article 31.1 of the VCLT supports the notion that terms such as "master," "in charge of," and "serving on" imply a physical presence aboard a vessel, aligning with the broader objectives of maritime conventions to ensure safe and secure navigation. Current regulatory frameworks are inadequate for addressing the challenges posed by maritime autonomous vessels.

What is an Autonomous vessel?

The global autonomous shipping market was valued at USD 6.57 billion in 2019 and is expected to reach USD 10.74 billion by 2030, growing at a CAGR¹² of 4.5%¹³. The market is driven by advancements in AI, machine

learning, and sensor fusion, enabling ships to operate with minimal to no human intervention. The significance of semi-autonomous vessels in 2023, accounted for about 77.1% of revenue. Governments and private companies are investing heavily in autonomous ship technologies, with the Asia-Pacific region leading the way at 31.4%. Fully autonomous ships are expected to generate USD 2.68 billion by 2033, reshaping maritime sector¹⁴. The algorithm serves as the brain for an autonomous vessel, enabling real-time decision making through the artificial intelligence, sensor inputs, and machine learning. The term "autonomous vessel" does not imply complete absence of crew members, but it denotes where limited to no crew members are physically aboard. By utilizing advanced communication networks, autonomous ships operate on shore-based control centers, where experts monitor operations and intervene whenever necessary. These vessels operate using pre-programmed algorithms, learning models, and automated responses to environmental conditions, ensuring safety compliance. This approach blends automation with human expertise, optimizing maritime operations from commercial shipping to naval defense, marking a significant evolution in ocean transportation. Autonomous vessels in naval warfare rely on advanced collision avoidance programs to ensure safe navigation in complex maritime environments¹⁵. The International Maritime Organization (IMO) uses the term Maritime Autonomous Surface Ships (MASS) to refer the Autonomous vessel that functions with minimal or no direct human involvement in their operations¹⁶. Ships with varying degrees of automation can be categorized into four¹⁷:

In the first degree, with seafarers- ships features as automated processes and decision-support systems, but seafarers remain on board to oversee operations and manage shipboard functions.

In the second degree, with seafarers- consists of remotely controlled ships where external operators manage the vessel from another location while seafarers are still present on board.

⁹. Every description of watercraft, including non-displacement craft, WIG (wing-in-ground) craft, and seaplanes, is used or capable of being used as a means of transportation on water.

¹⁰. A vessel of any type that is not permanently attached to the seabed, including dynamically supported craft, submersibles, or any other floating craft.

¹¹. Vienna Convention on the Law of Treaties, May 23, 1969, 1155 U.N.T.S. 331.

¹². It is the annualised growth rate of investments over a specific period of time. Rick Wayman, What Compound Annual Growth Rate (CAGR) Tells Investors, Investopedia, <https://www.investopedia.com/investing/compound-annual-growth-rate-what-you-should-know/>, accessed on April 23, 2025.

¹³. Autonomous Ships Market, Supra, 2

¹⁴. Id.,

¹⁵. Marilia Ramos, Ingrid Utne & Ali Mosleh, Collision Avoidance on Maritime Autonomous Surface Ships: Operators' Tasks and Human Failure Events, 116 Safety Sci. 33, 33-44 (2019), available at <https://www.researchgate.net/publication/331684308>

¹⁶. IMO MSC 98/20/2 of 27 February 2017.

¹⁷. International Maritime organization, Autonomous vessel, <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx/>, accessed on May 9, 2025.

In the third degree, without seafarers- ships are remotely controlled, but there is no crew members physically aboard, with all operations handled from a separate location.

In the fourth degree, without seafarers- fully autonomous ships operate independently, with onboard systems capable of making decisions and executing actions without human intervention.

Evolution of usage of autonomous vessel in naval warfare:

Naval warfare has evolved significantly through technological advancements, from the Portuguese caravels in the 15th century to the British Royal Navy's supremacy in the 19th century¹⁸. The 20th century marked significance with the introduction of nuclear submarines, and guided missiles, thus fundamentally altering military strategies and redefining global naval security doctrines. Remote-controlled boats loaded with explosives were used in the English Channel during the First World War. The German Imperial Navy's World War?I used the remote controlled explosive boats known as Fernlenkboote and extending to World War?II¹⁹. Then the Japanese deployed remotely guided attack craft to support their conventional forces. In 2005, Lu'ai Sakra, a group affiliated with al Qaeda, carried out an attack by steering a small boat packed with explosives into an Israeli cruise ship which was transporting passengers enroute to Turkey²⁰. Similarly, in 2017, the Houthis used a drone boat to strike a Saudi frigate. In the modern landscape of global power competition, states are largely investing in autonomous technologies to enhance their edge in warfare. Canada is yet to trial maritime autonomous vessels²¹.

The U.S. Navy leads the way in autonomous warfare, prioritizing the development of uncrewed platforms to maintain and expand its military-technological

advancement, for example- the US Navy has been integrating unmanned systems through initiatives like the DARPA NOMARS program²², which led to the development of the USX-1 Defiant by Serco. Additionally, the U.S. Navy established Unmanned Surface Vessel Squadron Three, deploying Global Autonomous Reconnaissance. Moreover, companies such as Northrop Grumman have also been active, developing autonomous undersea systems aimed at enhancing situational awareness and undersea warfare capabilities. The Marine Corps²³ deployed the autonomous Navy-Marine Expeditionary Ship Interdiction System (NMESIS) in the Philippines, a missile system mounted on an unmanned Joint Light Tactical Vehicle designed to interdict enemy ships. This move, part of their Remotely Operated Ground Unit for Expeditionary Fires program, shift toward unmanned, autonomous operations in naval warfare. Tardid's Aquatle A5 - Meglan²⁴ is an autonomous surface vessel useful for maritime surveillance and security. Powered by its Brainbox AI platform, it can "see, hear, and understand" its surroundings to effectively function and secure zones. China is also advancing in autonomous vessel, with several classes of surface and underwater submarines in testing. India is marking significant strides in integrating autonomous naval technology into its defence strategy. The Indian Navy has successfully tested Autonomous Weaponized Boat Swarms²⁵. In addition to it, Indian Navy is working on unmanned underwater capabilities through a ₹2,500 crores initiative to develop over 100-tonne unmanned underwater vehicles for mining purpose, surveillance, and anti-submarine warfare. The proposed unmanned underwater capabilities will enhance India's naval presence by conducting prolonged operations in deep waters, tracking suspicious movements, and protecting national interests. The Ministry of Defence (MoD) is expected to issue a tender under the

¹⁸. Neil Westphalen, Victorian Naval Warfare, Ships and Medicine 1815-1900, J. Mil. & Veterans' Health, <https://jmvh.org/article/victorian-naval-warfare-ships-and-medicine-1815-1900/>, Accessed on July 23, 2025.

¹⁹. David Koch, German Explosive Remote-Control speedboats of WW1 and WW2, Standing Well Back (Feb. 5, 2020), <https://www.standingwellback.com/german-explosive-remote-control-speedboats-of-ww1-and-ww2/>, accessed on may 9, 2025.

²⁰. C. Onur Ant, Israeli Cruise Attack Plot Exposed, CBS News (Aug. 11, 2005), <https://www.cbsnews.com/news/israeli-cruise-attack-plot-exposed/>, accessed on July 23, 2025.

²¹. Kate Todd, Canadian global affairs institute triple helix Autonomous Vessels Are Revolutionizing Naval Warfare: Can Canada Keep Up? https://www.cgai.ca/autonomous_vessels_are_revolutionizing_naval_warfare_can_canada_keep_up, Accessed on may 8, 2025.

²². The NOMARS program rethinks naval design by building ships with no human accommodations. This approach promises benefits including reduced size and cost, improved sea reliability both in rough sea conditions and against adversary actions through better stealth and tamper resistance.

²³. National Defense Magazine, "Autonomous Vessel Proving its Worth to Forward-Deployed Marines, April 9, 2025. <https://www.nationaldefensemagazine.org/articles/2025/4/9/autonomous-vessel-proving-its-worth-to-forward-deployed-marines>, accessed on May 9, 2025.

²⁴. Tardid, the developer of the Aquatle A5 - Meglan, is an Indian company headquartered in Bengaluru, Karnataka, India. Refer, <https://www.tardidtech.com/>, accessed on July 30, 2025.

²⁵. Developed by Pune-based company Sagar Defence Engineering, and placed an order for 12 units -10 for naval operations and two for deployment in Pangong Tso. The Autonomous Weaponized Boat Swarms system enhances maritime security by leveraging strengthened surveillance and combat capabilities. Refer, <https://defence-blog.com/indias-autonomous-weaponized-boat-spotted-in-mumbai/>, accessed on July 30, 2025.

Make-1 procedure, inviting Indian shipyards to contribute under the Atma Nirbhar Bharat initiative. The increasing reliance on unmanned systems reflects a broader shift in naval warfare, where it's crucial for maintaining strategic advantages, particularly in regions like the Indo-Pacific²⁶. Similarly, Russia has integrated autonomous underwater vessels into its naval operations. During the Russia-Ukraine war²⁷, Ukraine has deployed unmanned surface vessels in naval combat Magura-7 drone boat, an autonomous USV armed with AIM-9 Sidewinder missile was used to down a Russian Su-30 fighter jet. It highlights evolving maritime tactics and highlighting the growing role of autonomous platforms in modern warfare.

These advancements are revolutionizing naval warfare and fleet composition strategies. The U.S. Navy aims for autonomous vessels to comprise 30 percent of its fleet by 2045, leveraging AI to enhance operational efficiency and complicate enemy targeting efforts²⁸. These vessels will take on high-risk missions, improve surveillance and situational awareness, and sustain prolonged operations, thereby reducing the burden on human personnel. With emerging threats like hypersonic weapons and autonomous swarming systems, militaries are increasingly relying on uncrewed vessels to detect, react, and make tactical decisions faster than human counterparts ever could.

Role of IMO in regulating Autonomous vessel:

The objective of the IMO is to integrate emerging technologies into its regulatory framework by carefully examining their advantages with safety, security, environmental impact, international trade facilitation, and their effects on crew members both on board and ashore. Thus, the IMO aims to ensure that MASS remains aligned within the regulatory framework. The IMO Maritime Safety Committee first discussed in 2017 about how MASS aligns with existing IMO instruments²⁹. In 2018, MSC adopted a framework for a regulatory scoping exercise for MASS operations that was completed in 2021. As a result, Outcome of the Regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS) came. The Joint Working Group on MASS formed as a collaborative mechanism to tackle common regulatory concerns

identified during scoping exercises, it includes Maritime Safety Committee, Legal Committee, and Facilitation Committee. This group meets regularly to ensure a coordinated approach to addressing challenges addressing the regulation of MASS

Maritime Safety Committee assessed the impact of Maritime Autonomous Surface Ships (MASS) on existing regulations, found that revisions or new instruments needed³⁰. Autonomous and remote-controlled ships are undergoing trials, with suggestion that autonomous operations will remain limited to short-distance voyages between specific ports.

Interim guidelines for MASS trials have been introduced to support regulatory developments³¹. Additionally, the CMI³² Executive Council formed a working group to examine international legal frameworks and identify the necessary amendments for Unmanned Maritime Systems (UMSs). A global scenario revealed that 90% of nations recognize UMSs as ships under their domestic laws, highlighting widespread acceptance and the need for a regulatory framework to facilitate autonomous vessel operations³³.

The IMO Maritime Safety Committee established a timeline for the development of the Maritime Autonomous Surface Ships (MASS) Code, aiming to finalize and adopt a non-mandatory version by May 2026, followed by an Experience-building phase (EBP) framework in December 2026. The mandatory MASS Code will be developed from 2028 based on findings from the EBP and sub-committee reviews, is expected to be adopted by July 2030 and enforcement from January 2032. The regulatory scoping exercise looked into key maritime concerns, including safety, security, liability, environmental protection, port interactions, pilotage, and incident responses, assessing existing IMO provisions for their applicability to MASS.

Despite developing the MASS Code, various levels of uncertainties remain regarding its implementation, particularly how states will adapt to evolving technologies and regulatory challenges. The feasibility of new terminologies within national legal frameworks raises concerns about long-term legislative support. If the normal operation of Maritime Autonomous Surface Ships (MASS) arises various questions, their use in naval warfare ranging

²⁶. Autonomous Platforms in Sea Warfare, <https://www.spsnavalforces.com/experts-speak/?id=758&h=Autonomous-Platforms-in-Sea-Warfare>, accessed on may 11, 2025

²⁷. Kateryna Zakharchenko, Ukraine Naval Drone Shoots Down Two Russian Warplanes in 24 Hours: First-Ever USV Fighter Jet Kills (Updated), (May 4, 2025), <https://www.kyivpost.com/post/51994>, accessed on May 9, 2025.

²⁸. Kate Todd, Autonomous Vessels Are Revolutionizing Naval Warfare: Can Canada Keep Up?

²⁹. Can.Glob.Aff.Inst.(Dec.2023), https://www.cgai.ca/autonomous_vessels_are_revolutionizing_naval_warfare_can_canada_keep_up, accessed on July 30, 2025.

³⁰. IMO Doc. MSC 98/20/2, 2017.

³¹. IMO Doc. MSC.99/WP9, 2018; IMO Doc. MSC/99/22; IMO Doc. MSC.1/Circ. 1638 (2021).

³². IMO Doc. MSC.1/Circ. 1604, 2019.

³³. Founded in Antwerp in 1897, CMI is an international, non-governmental, and not-for-profit organization committed to advancing the unification of maritime law. Refer, Comité Maritime International, <https://comitemaritime.org>, accessed on July 30, 2025.

from surveillance to combat develops further complexities. Thus, questions arise about how MASS aligns with the existing international laws governing law of armed conflict, humanitarian principles, and warfare regulations, emphasizing the need for comprehensive legal review and adaptation to ensure compliance with global legal standards.

Legality of Autonomous vessel:

The legality of autonomous vessel plays a crucial role in determining the basic principles like right to innocent passage, freedom of navigation. In order to qualify, first flag state must ensure compliance under existing primary international instruments like UNCLOS³⁴, MARPOL³⁵ etc. U.S. maritime law does not differentiate a vessel where is it manned or unmanned, and it has the same status under the law of the sea. These vessels can exercise the right of innocent passage in territorial and archipelagic waters, provided primarily they do not threaten the peace and security of the coastal states. This means they must refrain from activities that interfere with coastal state such as using force, gathering intelligence or interfering with communication systems. They cannot engage in activities such as weapon exercises, military device deployment, or unauthorized research without the consent of coastal state. Freedom of navigation also includes transit passage through international straits without obstruction, archipelagic sea lanes passage allowing free movement through designated routes, and high seas freedoms, including navigation and over flight beyond territorial waters. As per UNCLOS when these vessels exercise innocent passage must navigate on the surface and display their flag. In case of violation of territorial sea laws and refuses to comply, the coastal state can demand its immediate departure, though enforcement mechanism might be challenging due to the lack of onboard personnel. The flag state is also responsible for the violations or damages inflicted by it. Apart from these, coastal state or archipelagic state can establish traffic separation scheme³⁶ and sea lanes for secure navigation- this should also be compiled by MASS. However when these autonomous vessels are owned by government used for non- commercial purpose then they are exempted from these regulations due to sovereign immunity. While navigating in Exclusive Economic Zones, it must respect the

coastal state's resource rights. Thus autonomous vessels are recognized as legitimate entities with navigation freedoms akin to manned ships, but they also carry legal responsibilities and restrictions to ensure maritime safety and security for safe, secure shipping.

Usage of Autonomous vessel in defence mechanism:

Autonomous vessels play a transformative role in modern naval facilities by enhancing surveillance, patrolling, and combat operations while minimizing human risk. A single shore-based operator can manage an entire fleet, optimizing surveillance over large areas efficiently. Unmanned patrol boats can provide uninterrupted patrolling service in maritime borders and strategic points without requiring crew members. These vessels integrate with situational awareness systems like radar, Automatic Identification System, GPS, AI driven analytics and sensors to execute missions with minimal to no human involvement. Remote payload control enables operators to manage onboard equipment such as cameras, cranes, launch stations, weapons, and anti-piracy tools. These systems to identify threats, and illicit trafficking prevention. Operators can access this data from virtually anywhere to execute missions safely and securely³⁷. For specialized operations, unmanned vessels help minimize loss of human life to hostage situations. Drone boats can act as diversions, facilitating crewed operations while reducing risk. In extreme circumstances, operators can remotely access, control, delete sensitive data, or override vessel functions to prevent harmful events. Ultimately, autonomous marine technology allows unmanned vessels to handle high-risk hostile tasks, protecting personnel while maintaining operational effectiveness.

Emerging issues of Autonomous vessel in warfare:

The increasing shift towards autonomous vessels in warfare presents significant challenges for underdeveloped nations, potentially placing them at a disadvantage. When advanced naval technologies are exported, they raise concerns about espionage, as developed countries could use these systems to secretly gather intelligence on naval movements and defensive strategies. The integration of autonomous vessels requires substantial modifications to ethical policies, naval doctrines, and cyber security frameworks³⁸. Additionally, training personnel to operate

³⁴. Raul Pedrozo, Advent of a New Era in Naval Warfare: Autonomous and Unmanned Systems, in *Autonomous Vessels in Maritime Affairs* pp 63- 80, SpringerNature Link.

³⁵. UNCLOS, Supra note 3.

³⁶. International Convention for the Prevention of Pollution from Ships, adopted Nov. 2, 1973, as modified by the Protocol of 1978, and amended by the Protocol of 1997, 1340 U.N.T.S. 184 entered into force Oct. 2, 1983.Refer, [https://www.imo.org/en/about/conventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-\(marpol\).aspx](https://www.imo.org/en/about/conventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-(marpol).aspx), accessed on July 30,2025.

³⁷. UNCLOS, supra note 2, Art. 22.

³⁸. Aastha Verma, The Future of Maritime Security: Autonomous Surveillance Vessels, *Indian Aerospace & Def. Bull.* (Nov. 3, 2024), <https://www.iadb.in/2024/11/03/the-future-of-maritime-security-autonomous-surveillance-vessels/> , accessed on July 30, 2025.

³⁹. Maik, Hasina & Afridi, Sheeba. (2024). The Role of Artificial Intelligence in Modern Warfare and International Security, researchgate,

and maintain these systems is crucial to ensuring their effectiveness and security. Autonomous vessels face various security threats, including disruptions to radio signals, sensor interference, interception or modification of communications, and attacks targeting both operational and information technology systems. Cyber threats can compromise the artificial intelligence that governs autonomous operations, while vulnerabilities in supply chains, physical security, and shore-based control centers further increase risks³⁹.

The use of autonomous vessel in naval warfare is becoming increasing, as seen in the Black Sea conflict⁴⁰. According to Article 29, a warship belonging to a state's armed forces should display external nationality marks, be commanded by a officer operated by a disciplined crew, further citing the Vienna Convention on the Law of Treaties, allows interpretation in light of new developments. This definition links UNCLOS to International Humanitarian Law (IHL), reinforcing the principle of distinction i.e., requirement to distinguish between combatants and non-combatants and ensuring lawful conduct during warfare. The United States has echoed this position, updating its Commanders' Handbook⁴¹ to recognize that warships can be remotely controlled and still exercise legal navigational rights under international law. Autonomous vessels reduce costs and risks to personnel, making them a strategic military asset both in peacetime and during conflict.

As of now, this technology is still evolving, specific countermeasures remain difficult to establish. Security strategies will vary based on specific vessel usage and the degree of autonomy, but identifying potential threats and implementing preventive measures can help engineers, owners, and operators enhance security. To mitigate these risks, naval forces must implement strong security protocols, encryption techniques, and setback control mechanisms that allow human intervention when necessary.

Law of Armed conflict:

Law of armed conflict also known as International Humanitarian law is a customary international law containing a set of body of rules governing states during war and limit the effect of armed conflict. International humanitarian law is mainly shaped by four Geneva Conventions of 1949, and others⁴² which have been widely accepted by nearly all states. These Conventions serve as fundamental legal document for the protection of individuals during armed conflicts. Further, the Additional Protocols of 1977⁴³, relating to protections for victims of warfare was developed. These laws mainly apply only during armed conflicts and involvement of two or more states. International humanitarian law protects civilians, medical personnel, and those not participating in combat, ensuring humane treatment. It forbids harming surrendered or incapacitated enemies and mandates care for the wounded. Warfare restrictions prohibit indiscriminate attacks, environmental damage, banning hazardous chemical weapons. States must compile with these standards, enact laws against war crimes, and support international community to uphold justice. The basic principles of law of armed conflict are distinction, proportionality, military necessity and limitation. These principles emphasize distinctions between combatants and non-combatants, protecting them unless they directly engage in hostilities. Military necessity justifies only reasonable force, prohibiting excessive actions. Proportionality ensures that civilian harm remains minimal relative to military advantage, preventing unwanted destruction. Limitation principles restrict the choice of weapons to comply with legal constraints.

Autonomous vessel under International humanitarian law:

Traditional warfare requires human command and control, as well as the immunity of government ships. However, autonomous vessels lack crew members, raising concerns about their compliance with international humanitarian law. The Martens Clause⁴⁴ ensures protection for both civilians and combatants, even in cases

https://www.researchgate.net/publication/386341455_The_Role_of_Artificial_Intelligence_in_Modern_Warfare_and_International_Security, accessed on July 30, 2025.

⁴⁰. Palbar Misas, Juan & Hopcraft, Rory & Tam, Kimberly (2022). Future of Maritime Autonomy: Cybersecurity, Trust and Mariner's Situational Awareness, research gate, https://www.researchgate.net/publication/379122060_Future_of_Maritime_Autonomy_Cybersecurity_Trust_and_Mariner's_Situational_Awareness, accessed on July 30, 2025.

⁴¹. David Kirichenko, Ukraine's Innovation Is Raising the Standards of Naval Warfare, *Tomorrows Aff.* (Apr. 9, 2025), <https://tomorrowsaffairs.com/ukraine-s-innovation-is-raising-the-standards-of-naval-warfare>, accessed on July 30, 2025.

⁴². The Warship's Remote Operator: Who Is the Captain Now?, *Lawfare*, <https://www.lawfaremedia.org/article/the-warship-s-remote-operator-who-is-the-captain-now->, accessed on July 30, 2025.

⁴³. The 1954 Convention for the Protection of Cultural Property in the Event of Armed Conflict, the 1972 Biological Weapons Convention, the 1980 Conventional Weapons Convention, the 1993 Chemical Weapons Convention, the 1997 Ottawa Convention on anti-personnel mines, the 2000 Optional Protocol to the Convention on the Rights of the Child on the involvement of children in armed conflict.

⁴⁴. Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I), June 8, 1977, <https://ihl-databases.icrc.org/en/ihl-treaties/api-1977>, accessed on July 30, 2025.

not covered by treaties, upholding the principles of humanity and public conscience. Autonomous vessels with limited or no human involvement present accountability challenges and raise questions about their role in naval warfare. The growing unease regarding fully autonomous weapons reflects broader moral concerns, emphasizing the need for human oversight in the use of force.

Article 36 of Protocol I requires states to assess whether new weapons comply with legal norms⁴⁵. Weapons must not be indiscriminate or have uncontrollable effects. Therefore, the inclusion of autonomous vessels in warfare must ensure compliance with distinction, proportionality, and necessity. Humans rely on real-time combat analysis regardless of prior experience, whereas autonomous vessels operate based on programmed instructions. Applying the principle of distinction in autonomous systems creates difficulties in differentiating military and civilian targets. Similarly, the principle of proportionality poses challenges in complex environments, making assessments difficult for autonomous vessels.

In order to ensure compliance with International Humanitarian Law (IHL) in autonomous weapon systems requires maintaining meaningful human control over their use of force. The Convention on Certain Conventional Weapons reinforces retaining human judgment in lethal force decisions⁴⁶, while the International Committee of the Red Cross emphasizes human oversight to meet legal standards. Human control is most important at all various stages, including trials, activation, and operation. Therefore, though autonomous weapons can autonomously identify and strike targets, human oversight is crucial aspect to ensure that operations align with user intentions, prevent unlawful actions, and comply with international humanitarian law. Testing ensures predictability, commanders set operational limits, and oversight allows intervention. Without limits, autonomy risks unlawful targeting and violations. Predictability is vital for IHL compliance in autonomous weapons. Human supervision may meet legal standards, but complex AI-driven weapons risk unpredictability in autonomous weapons. Greater autonomy and adaptability increase unpredictability, raising concerns about unintended violations of IHL. The principle of accountability is well

recognised under international humanitarian law making states responsible for their options. In autonomous vessels, liability moves to manufacturers, programmers who lack knowledge of future consequences.

Conclusion:

Autonomous vessels, powered by AI, machine learning, and advanced sensors, are revolutionizing naval warfare and maritime security by performing tasks like reconnaissance, surveillance, and combat with unmatched precision and endurance. These Maritime Autonomous Surface Ships (MASS) reduce human risk, enabling operations in hazardous environments without endangering personnel. Their integration enhances maritime security by effectively countering threats such as armed robbery, piracy and smuggling through continuous patrolling and rapid response capabilities, safeguarding global trade routes. However, their deployment in warfare reveals a dual-edged impact. On one side, navies using autonomous vessels gain strategic advantages, minimizing human casualties while executing high-risk missions with efficiency. Conversely, opposing forces without comparable technology may suffer significant losses due to the speed and accuracy of these systems. When both sides employ autonomous vessels, outcomes become unpredictable, risking unintended escalations and collateral damage. The absence of onboard crews challenges traditional accountability and compliance with the United Nations Convention on the Law of the Sea (UNCLOS) and International Humanitarian Law (IHL), raising critical questions about liability and ethical conduct. Determining responsibility related to whether it lies with states, manufacturers, or programmers remains complex, particularly in combat scenarios where AI-driven decisions may lead to violations. As technology evolves, international cooperation, led by initiatives like the International Maritime Organization's MASS Code mandatory adoption by 2032, is essential to develop updated regulations. These must ensure autonomous vessels operate within legal and humanitarian boundaries, upholding principles of humanity, distinction, and proportionality. Only through such global efforts can their transformative potential be realized while maintaining compliance with international war laws and enhancing maritime security.

⁴⁵. The principles of humanity and dictates of public conscience are mentioned in article 1(2) of Additional Protocol I and in the preamble of Additional Protocol II to the Geneva Conventions.

⁴⁶. Commentary of 1987: Article 36 - New Weapons, in Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I), June 8, 1977, <https://ihl-databases.icrc.org/en/ihl-treaties/api-1977/article-36/commentary/1987>, accessed on July 30, 2025.

⁴⁷. The Convention on Certain Conventional Weapons (CCW), formally amended on 21 December 2001, is a pivotal instrument of international humanitarian law. It aims to prohibit or limit the use of particular categories of weapons that are deemed to inflict excessive harm on combatants or pose indiscriminate risks to civilian populations. Refer, <https://disarmament.unoda.org/the-convention-on-certain-conventional-weapons/>, accessed on July 30, 2025.

Between Law and War: A Critical study on Human Rights Violations and the Role of International Legal Mechanisms

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ABSTRACT

Confronted with the greatest threats to human rights ever seen, and occurring in a rapidly shifting warfare landscape, the international legal framework wavers. Cyber operations, autonomous weapon systems, the use of targeted drone strikes and hybrid military strategies have transformed the warfare, frequently challenging established rules of international law. This paper conducts such a critical study of an increasing disconnection between the conduct of modern warfare and the global obligation to uphold human rights - one that exposes systemic failures whereby legal standards being affected by the geopolitical reality.

This paper explores the complex interrelationship between International Humanitarian Law (IHL) and International Human Rights Law (IHRL) in the context of modern day armed conflict. Using a case and doctrinal based approach, the analysis assesses how well current legal mechanisms which include the Geneva Conventions, the Universal Declaration of Human Rights (UDHR), the International Covenant on Civil and Political Rights (ICCPR) and the Rome Statute of the International Criminal Court (ICC) function in aiding in the prevention of genocide and crimes against humanity. Syria, Ukraine, Gaza and Afghanistan are used as case studies to illustrate flagrant violations of international standards including widespread patterns of civilian targeting, forced displacement, and war crimes, highlighting how legal mechanisms often fall short of ensuring state accountability.

The paper also analyses the emerging threats like biotechnological warfare and cyberattacks, as well as the environmental degradation associated with military operations, all of which exist in legal grey zones of international law. Furthermore, an analysis is made of the particular burden placed on non-combatants, particularly women, children and refugees, whose rights are frequently violated without adequate redressal mechanisms.

In the Indian context, this paper discusses about its evolving role on global humanitarian governance, such as India's nearness and contemporaneous participation in international humanitarian laws, its non-ratification of the Rome Statute, its (signification through UN peace keeping missions), domestic legal instruments like the Protection of Human Rights Act, 1993 and how that would posed in the global regime of international humanitarian law. It also discusses India's stance on humanitarian intervention and the Responsibility to Protect (R2P) doctrine in the context of internal security challenges.

Ultimately, this paper also attempts to connect an expanding gulf between legal norms and the realities of warfare. It contends that even if the architecture of international law can provide a common ground to regulate armed conflict, its enforcement remains limited, political, and often out of reach for those who suffer from war. The paper ends by suggesting structural reforms, including the strengthening of investigative mechanisms, greater cooperation between states and international tribunals, and revision of legal definitions to better capture contemporary sources of danger, aimed at creating a more responsive and rights based legal framework for governing conflict.

Keywords: International Humanitarian Law (IHL), International Human Rights Law (IHRL), Modern warfare, Cyber operations, Autonomous weapon systems, Targeted drone strikes

Introduction

The landscape of armed conflict has shifted dramatically in the twenty-first century. Traditional warfare-defined by direct confrontations and territorial disputes-has been overtaken by multifaceted conflicts that blend cyber warfare, autonomous systems, and unconventional tactics. These new modalities challenge the established legal and ethical frameworks intended to protect human

rights in times of war. Notably, the relationship between International Humanitarian Law (IHL) and International Human Rights Law (IHRL) has become increasingly complex, exposing significant ambiguities in interpretation, jurisdiction, and enforcement. This paper critically examines the discord between the evolving realities of warfare and the legal regimes designed to regulate them. IHL, primarily founded on the Geneva Conventions¹ and their Additional Protocols, regulates

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conduct during hostilities and seeks to minimize suffering in armed conflict. In contrast, IHRL, anchored in instruments such as the Universal Declaration of Human Rights and the International Covenant on Civil and Political Rights², applies universally-both in peace and during conflict. Although these legal systems are distinct, their concurrent application in modern conflicts demands a nuanced analysis of their points of convergence and divergence, especially where the *lex specialis* principle gives IHL precedence during hostilities.

The impetus for this research arises from persistent and egregious violations of human rights in recent conflicts, including those in Syria, Ukraine, Gaza, and Afghanistan³. Despite the existence of robust legal norms prohibiting attacks on civilians, torture, and forced displacement, such violations remain widespread. The limited effectiveness of international mechanisms-such as the International Criminal Court and the United Nations Security Council-in deterring or prosecuting these crimes highlights deep-seated deficiencies within the international justice system. This paper also addresses emerging legal grey areas, particularly those arising from technological advancements in warfare. Issues such as unaccountable drone strikes and environmental harm caused by military operations test the limits of current legal principles. The heightened vulnerability of non-combatants-including women, children, and displaced persons-further exposes the inability of existing legal structures to provide adequate and timely protection.

Within this broader context, the Indian legal framework is analyzed, focusing on the nation's peacekeeping efforts, its stance on the Rome Statute, and the relevance of domestic legislation like the Protection of Human Rights Act, 1993. India's approach to the Responsibility to Protect (R2P) doctrine is also scrutinized, particularly in relation to internal security and regional responsibilities.

Employing both doctrinal and case-study methodologies, this paper identifies critical gaps in the enforcement of international norms and proposes pragmatic reforms to bridge the divide between legal theory and the realities of contemporary warfare. Ultimately, while international law holds the promise of humanizing armed conflict, this potential remains largely unrealized without comprehensive structural reform, genuine political commitment, and a renewed dedication to upholding the dignity and rights of all individuals.

I. THE SHIFTING LANDSCAPE OF MODERN WARFARE

The conventional conception of warfare-characterized by defined frontlines, identifiable combatants, and formal declarations-has been fundamentally altered by advances in technology and shifting geopolitical realities. Contemporary armed conflicts are no longer confined to traditional inter-state hostilities; instead, they encompass a complex interplay of state and non-state actors, proxy engagements, insurgencies, cyber operations, and the deployment of autonomous systems. These developments have exposed the limitations of international legal instruments, many of which are anchored in mid-twentieth-century paradigms.

A pivotal transformation in the conduct of hostilities is the integration of cyber operations as mechanisms of coercion and aggression. States now routinely employ cyber-attacks targeting critical infrastructure, financial institutions, and communication networks of adversaries, often without triggering the conventional thresholds of armed conflict as articulated in Article 2(4) of the United Nations Charter⁴. Such acts, while potentially devastating, frequently elude precise legal classification under the doctrines of *jus ad bellum* and *jus in bello*, thereby creating normative lacunae where accountability is ambiguous and attribution is inherently problematic.

The proliferation of unmanned aerial vehicles⁵ (UAVs), commonly referred to as drones, represents another significant evolution in warfare. These platforms facilitate targeted strikes, surveillance, and intelligence gathering far beyond traditional battlefields. While drone technology ostensibly enhances precision, its use has been associated with extrajudicial killings and collateral damage, particularly in regions lacking active hostilities. The legality of these operations under International Humanitarian Law hinges on the principles of distinction, proportionality, and military necessity-principles that are frequently compromised when such actions are conducted under opaque counterterrorism frameworks devoid of effective judicial oversight.

The advent of autonomous weapon systems⁶ (AWS), which possess the capability to select and engage targets independently of direct human control, further complicates the legal landscape. These systems challenge foundational doctrines of command responsibility and individual criminal liability. When an autonomous system

¹. Geneva Convention Relative to the Protection of Civilian Persons in Time of War art. 3, Aug. 12, 1949, 75 U.N.T.S. 287.

². International Covenant on Civil and Political Rights, Dec. 16, 1966, 999 U.N.T.S. 171.

³. U.N. Human Rights Council, Report on Syria, U.N. Doc. A/HRC/49/73 (2022).

⁴. U.N. Charter art. 2, 4.

⁵. Human Rights Watch, *Between a Drone and Al-Qaeda: The Civilian Cost of US Targeted Killings in Yemen* (2013).

⁶. U.N. Office for Disarmament Affairs, CCW Meetings on Lethal Autonomous Weapons Systems.

perpetrates a violation of the laws of armed conflict, the question of culpability becomes obscured: should liability attach to the programmer, the operator, or the state itself? Existing treaty law, including the Geneva Conventions, is ill-equipped to address these emergent dilemmas, and efforts to promulgate new binding norms for AWS remain stymied by divergent state interests.

Hybrid warfare, as evidenced by recent operations in Crimea and Eastern Ukraine, exemplifies the fusion of conventional military force with cyber sabotage, disinformation campaigns, and irregular proxy forces. This amalgamation erodes the traditional demarcations between combatants and civilians, as well as between times of peace and armed conflict, thereby complicating the application of International Humanitarian Law. The principle of distinction—a cornerstone of civilian protection—is increasingly undermined when combatants operate clandestinely within civilian populations or engage in hostilities without clear identification.

Additionally, the privatization of military force through the widespread use of private military and security companies (PMSCs) introduces further legal complexity. These entities often function in environments with minimal regulatory oversight and may operate outside established chains of command, thus complicating the attribution of state responsibility and the enforcement of accountability under international law. Modern warfare, in its current manifestation, has thus outstripped the legal frameworks originally designed to regulate it. International law must now grapple not only with rapidly evolving technologies but also with novel forms of political and military conduct that exploit existing legal ambiguities.

II. THEORETICAL FRAMEWORK - IHL VS IHRL IN ARMED CONFLICTS

The dynamic between International Humanitarian Law (IHL) and International Human Rights Law (IHRL) is marked by both complementarity and contention, particularly within the context of modern armed conflicts. Although both legal regimes are dedicated to upholding human dignity, their respective spheres of application, normative underpinnings, and operational methodologies are distinctly different. The growing complexity of contemporary warfare has brought their interaction into sharper focus, as overlapping jurisdictions and novel conflict situations necessitate a reassessment of their respective roles.

IHL, commonly known as the law of armed conflict, is principally enshrined in the four Geneva Conventions of

1949 and their Additional Protocols⁷. Its purpose is to regulate the conduct of hostilities, restrict the means and methods of warfare, and safeguard individuals who are not, or are no longer, actively engaged in conflict. The core tenets of IHL include the principles of distinction, proportionality, necessity, and humanity. IHL is activated exclusively during periods of armed conflict—whether international or non-international in nature—and binds both state and non-state parties to hostilities.

Conversely, IHRL governs the relationship between the state and individuals at all times, encompassing both peacetime and periods of conflict. It is articulated through international instruments such as the Universal Declaration of Human Rights (UDHR), the International Covenant on Civil and Political Rights (ICCPR⁸), and various regional human rights treaties, including the European Convention on Human Rights (ECHR). While certain rights under IHRL may be lawfully suspended during states of emergency (as per Article 4 of the ICCPR), fundamental rights—such as the right to life, the prohibition of torture, and freedom from slavery—are absolute and remain enforceable at all times.

The simultaneous application of IHL and IHRL in armed conflict settings has generated significant theoretical and practical debate. The International Court of Justice (ICJ), in its Advisory Opinion⁹ on the Legality of the Threat or Use of Nuclear Weapons (1996) and the Legal Consequences of the Construction of a Wall¹⁰ (2004), affirmed that IHRL continues to operate during times of war. Nonetheless, when both legal frameworks are relevant, IHL is frequently regarded as the *lex specialis*—the specific law that governs the unique circumstances of armed conflict. This doctrine, however, has been critiqued for its potential oversimplification and lack of sensitivity to context, especially in situations where military operations impact civilian populations in ways not fully addressed by IHL alone.

The issue becomes even more pronounced in non-international armed conflicts (NIACs), where the legal landscape is less clearly defined. Common Article 3 of the Geneva Conventions sets out minimum protections, but lacks the comprehensive scope of treaty law applicable to international conflicts. Additionally, non-state armed groups, while participants in hostilities, are not always subject to the same legal obligations as states, resulting in enforcement challenges and normative disparities.

A further distinction arises in the mechanisms for accountability. Breaches of IHL may result in individual criminal liability, often adjudicated before international

⁷. Geneva Convention I-IV, Aug. 12, 1949, 75 U.N.T.S. 31, 85, 135, 287

⁸. European Convention on Human Rights, Nov. 4, 1950, 213 U.N.T.S. 221.

⁹. Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226.

¹⁰. Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory, Advisory Opinion, 2004 I.C.J. 136.

tribunals such as the International Criminal Court (ICC). In contrast, violations of IHRL generally trigger state responsibility, with enforcement mechanisms vested in human rights courts and treaty-monitoring bodies. This dichotomy can lead to fragmented or inconsistent responses to serious violations, particularly in conflicts involving both state and non-state actors.

Given the increasing complexity of armed conflict, there is a growing call to move beyond a binary approach. Rather than prioritizing one legal regime over the other, contemporary legal scholarship advocates for an integrated interpretation-where IHL and IHRL are applied in a complementary and context-specific manner. Such an approach is essential for ensuring that the law remains responsive to the realities of modern conflict, while maintaining its foundational commitment to the protection of human dignity.

III. CASE STUDIES - SYRIA, UKRAINE, GAZA, AFGHANISTAN

The gap between international legal standards and the actual conduct of warfare becomes starkly apparent when examining recent conflict zones. The situations in Syria, Ukraine, Gaza, and Afghanistan exemplify the persistent challenges faced by both International Humanitarian Law (IHL) and International Human Rights Law (IHRL) in preventing or addressing grave violations. These examples underscore systemic failures in enforcement, political deadlock, and the vulnerability of legal mechanisms amid evolving geopolitical realities.

• Syria: Systemic Collapse

Since the onset of civil war in 2011, Syria has become emblematic of widespread atrocities committed with near-total impunity. The conflict has seen indiscriminate aerial attacks, use of chemical weapons, sieges causing starvation, and targeted killings, all in direct violation of IHL principles such as distinction and proportionality. Reports by the United Nations Commission of Inquiry have repeatedly documented breaches of Common Article 3 of the Geneva Conventions and customary IHL.

The deployment of chemical agents by the Syrian government, notably in incidents such as the 2013 Ghouta attack and subsequent events in Khan Shaykhun and Douma, violated both IHL and IHRL, as well as the Chemical Weapons Convention¹¹. Despite substantial evidence, the United Nations Security Council has been unable to take decisive action due to the veto power exercised by permanent members, particularly Russia. This deadlock highlights the paralysis of the international legal system when confronted with geopolitical interests.

The humanitarian crisis has resulted in the forced

displacement of over 12 million Syrians, constituting violations of rights to life, adequate housing, and protection from refoulement under IHRL. Both government and opposition forces have committed acts that meet the criteria for war crimes and crimes against humanity under the Rome Statute, but Syria's non-party status to the Statute complicates the pursuit of justice.

• Ukraine: The Crime of Aggression Revisited

The Russian military intervention in Ukraine in 2022 has renewed focus on the prohibition of aggression under international law. The invasion breached Article 2(4) of the United Nations Charter, which forbids the use of force against the territorial integrity or political independence of states. The conflict has since escalated into a humanitarian crisis, marked by the use of cluster munitions, destruction of civilian infrastructure, and allegations of torture and summary executions in occupied regions.

Investigations by international bodies have confirmed violations of both IHL and IHRL, including attacks on hospitals and schools, deployment of prohibited weapons, and extrajudicial killings. Russia's withdrawal from several human rights treaties, including the European Convention on Human Rights, has further diminished legal protections for civilians.

The International Criminal Court has initiated inquiries into war crimes and crimes against humanity within its jurisdiction, but enforcement remains problematic due to limited cooperation from non-party states and the politicization of accountability mechanisms.

• Gaza: Civilian Protection and Proportionality

The ongoing conflict between Israel and Hamas in Gaza has continually tested the principle of proportionality under IHL. Israeli airstrikes, launched in response to rocket attacks, have caused extensive civilian casualties and widespread destruction of infrastructure. Operations such as Protective Edge (2014) and Guardian of the Walls (2021) have drawn international criticism for excessive use of force and collective punishment, both prohibited under the Fourth Geneva Convention. Conversely, Hamas has violated IHL by using civilians as shields, launching attacks from densely populated areas, and mistreating Israeli captives. The application of the dual-use doctrine by Israel to justify targeting certain infrastructure has been widely criticized for its lack of clarity and insufficient consideration of civilian harm.

From an IHRL standpoint, the rights to life, health, and education in Gaza have been severely compromised. The blockade imposed by Israel and Egypt has exacerbated humanitarian deprivation, potentially amounting to collective punishment. Efforts to initiate international

¹¹. OPCW-UN Joint Investigative Mechanism, Third Report, S/2016/738 (Aug. 24, 2016).

investigations have been hindered by political resistance and allegations of bias, revealing the limitations of legal mechanisms in highly politicized conflicts.

• **Afghanistan: The Erosion of Accountability**

Afghanistan's protracted conflict culminated in the Taliban's return to power in 2021 following the withdrawal of international forces. Throughout the conflict, all parties—including the Taliban, US and NATO forces, and Afghan security forces—have committed serious human rights abuses, such as attacks on medical facilities, extrajudicial executions, gender-based violence, and targeting of journalists and aid workers.

The International Criminal Court¹² authorized a comprehensive investigation into war crimes and crimes against humanity, including those committed by US nationals, leading to strong opposition from the United States. This standoff highlighted the fragility of international accountability mechanisms when powerful states are implicated. Since the Taliban's resurgence, the situation has further deteriorated, with women and girls facing systematic exclusion from education, employment, and public life—amounting to gender-based apartheid under evolving human rights standards. Ethnic minorities, especially Hazaras, continue to suffer targeted persecution. Despite Afghanistan's ratification of key human rights treaties, the absence of a functioning government has rendered these commitments largely ineffective.

These case studies collectively demonstrate the persistent gap between established legal norms and their enforcement. While international law unequivocally prohibits targeting civilians, torture, and forced displacement, both state and non-state actors continue to violate these standards with impunity. The inability of the international community to ensure accountability—due to jurisdictional limitations, political obstruction, or institutional weaknesses—has undermined the credibility of the legal frameworks designed to protect human rights.

Furthermore, these conflicts reveal the inadequacy of existing legal doctrines in addressing new forms of warfare and state conduct. The continued reliance on outdated enforcement mechanisms, coupled with selective political will, has resulted in a crisis of compliance in international law. For these legal frameworks to regain legitimacy and effectiveness, both IHL and IHRL must evolve to confront emerging threats, and the international community must commit to establishing more robust and impartial systems for justice and redress.

IV. GREY ZONES AND EMERGING THREATS IN INTERNATIONAL LAW

The framework of international law that governs armed conflict was originally developed at a time when warfare was primarily kinetic, state-controlled, and restricted by clear territorial boundaries. In the current era, however, conflicts increasingly take place within ambiguous legal and operational "grey zones," where the applicability of established legal norms is often unclear or disputed. These grey zones are not merely hypothetical; they are active theatres in which the protections of human rights and humanitarian law are frequently undermined, and effective legal accountability is rarely triggered.

A primary area of legal uncertainty is cyber warfare. Unlike traditional armed attacks, cyber operations can disable infrastructure, disrupt economies, manipulate political systems, and threaten civilian safety—all without the use of conventional weaponry. While the Tallinn Manual¹³ has sought to clarify how IHL principles might apply in cyberspace, its recommendations are non-binding and lack universal acceptance. As a result, crucial issues such as attribution, proportionality, and necessity remain unresolved in the digital domain. For example, a cyberattack on a hospital or power grid may have consequences equivalent to those of a physical assault, yet there is no comprehensive treaty that specifically governs state responsibility or accountability for such acts.

Biotechnological advancements, including the creation and potential weaponization of viruses, synthetic pathogens, and genetic modifications, present further ethical and legal dilemmas. The Biological Weapons Convention¹⁴ (BWC) prohibits the development and use of biological weapons, but its enforcement and verification mechanisms are inadequate. The dual-use nature of biotechnology makes it difficult to distinguish between legitimate scientific research and military applications, creating exploitable gaps for both state and non-state actors.

Autonomous weapon systems (AWS), sometimes referred to as "killer robots," push the boundaries of legal concepts such as intent, accountability, and proportionality. When an AWS autonomously selects and engages a target in violation of IHL, it is unclear where legal responsibility lies—whether with the programmer, the military commander, or the state. International discussions aimed at regulating AWS, including those under the Convention on Certain Conventional Weapons (CCW), have made little progress due to geopolitical disagreements and conflicting interests.

¹². ICC, Statement of the Prosecutor, Fatou Bensouda, on the Investigation in Afghanistan, Mar. 5, 2020.

¹³. Michael N. Schmitt et al., Tallinn Manual 2.0 on the International Law Applicable to Cyber Operations (Cambridge Univ. Press 2017).

¹⁴. Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) Weapons and on Their Destruction, Apr. 10, 1972, 1015 U.N.T.S. 163.

among major military powers.

Environmental harm resulting from armed conflict is another area that remains insufficiently addressed by current legal instruments. Warfare can devastate ecosystems, contaminate water sources, and destroy agricultural lands, yet most legal frameworks do not provide adequate protection against such damage. Although Additional Protocol I to the Geneva Conventions (specifically Articles 35 and 55) prohibits widespread, long-term, and severe environmental destruction, enforcement has been minimal. Environmental consequences are often regarded as incidental rather than as direct violations of international law.

Taken together, these grey zones illustrate a growing gap between the rapid pace of technological and strategic change and the slower evolution of international legal norms. In the absence of proactive legal adaptation, these ambiguous spaces continue to allow actors to operate without clear accountability, undermining the effectiveness of both humanitarian and human rights protections. Addressing these challenges will require not only legal innovation but also a concerted effort to build political consensus in the fragmented landscape of international law.

V. VULNERABILITIES OF NON-COMBATANTS AND HUMAN RIGHTS VACUUMS

In armed conflicts, civilians-rather than combatants-often bear the greatest burden of violence, despite explicit protections under International Humanitarian Law (IHL) and International Human Rights Law (IHRL). Although these legal regimes prohibit targeting non-combatants, recent conflicts have witnessed a systematic breakdown of such safeguards. Vulnerable groups including women, children, the elderly, and refugees frequently endure cycles of displacement, trauma, and abuse, often with little or no access to justice.

IHL, particularly through the Fourth Geneva Convention, mandates that parties to a conflict protect civilian populations and forbids practices such as collective punishment, indiscriminate attacks, and forced displacement. Likewise, human rights treaties such as the Convention on the Rights of the Child¹⁵ and the Convention on the Elimination of All Forms of Discrimination Against Women provide strong protections for civilians, even during emergencies. However, in many conflict zones, these protections remain largely theoretical, as laws are selectively enforced or disregarded altogether.

Women face unique vulnerabilities in conflict, notably sexual and gender-based violence including rape, forced

marriage, and sexual slavery. These acts are internationally recognized as war crimes and crimes against humanity under the Rome Statute¹⁶. Nevertheless, investigations and prosecutions are infrequent due to social stigma, evidentiary difficulties, and fear of retaliation, underscoring the inadequacies of legal redress mechanisms.

Children suffer severe consequences as well, including forced recruitment as child soldiers, exposure to violence, and disruption of essential services such as education and healthcare. Despite instruments like the Optional Protocol on the Involvement of Children in Armed Conflict, violations persist in various countries, resulting in long-term developmental damage and depriving entire generations of safety and opportunity.

Refugees and internally displaced persons face compounded hardships of displacement, statelessness, and marginalization. The principle of non-refoulement prohibits returning individuals to countries where they face serious threats. Yet political resistance to refugee admission, securitization of asylum policies, and detention of displaced persons reveal the fragility of these international commitments.

These realities expose a profound human rights vacuum-not due to the absence of legal norms, but because enforcement mechanisms are often weak, politicized, or non-existent. The widening gap between the promises of international law and their implementation leaves the most vulnerable populations without protection, representation, or voice.

VI. INDIA'S ROLE IN INTERNATIONAL HUMANITARIAN GOVERNANCE

India's approach to international humanitarian and human rights law is characterized by a combination of constitutional principles, strategic caution, and selective engagement at the global level. As the world's largest democracy and a rising international actor, India is increasingly expected to clarify its position within the global legal system. Its stance is shaped by robust domestic legal traditions, significant contributions to peacekeeping, and a measured approach to participation in international criminal law mechanisms.

Domestically, India's Constitution embeds human rights protections through its Fundamental Rights provisions, which align with global standards on rights such as life, equality, and liberty. The Protection of Human Rights Act, 1993¹⁷, established the National Human Rights Commission to address violations, positioning India among the few developing nations with a formal

¹⁵. Convention on the Rights of the Child, Nov. 20, 1989, 1577 U.N.T.S. 3.

¹⁶. Rome Statute of the ICC art. 7(1)(g), July 17, 1998, 2187 U.N.T.S. 90.

¹⁷. The Protection of Human Rights Act, No. 10 of 1994, § 3, India Code (1994).

institutional structure for human rights oversight. Nevertheless, enforcement at the national level is often hampered by procedural delays, bureaucratic challenges, political pressures, and restricted jurisdiction over military operations in conflict-affected regions.

On the international stage, India is a party to all four Geneva Conventions of 1949 and has ratified major human rights treaties, including the ICCPR, ICESCR, CEDAW, and CRC. However, India has not ratified the Additional Protocols to the Geneva Conventions or the Rome Statute of the International Criminal Court, reflecting a deliberate stance on sovereignty and external intervention. India has consistently voiced reservations about the risk of politicization, selective enforcement, and the potential infringement on state sovereignty by international criminal justice mechanisms, especially where these may be used to scrutinize domestic security operations or border disputes.

Despite these reservations, India has played a prominent role in the international humanitarian system, notably through its longstanding participation in United Nations Peacekeeping Operations¹⁸. Since 1948, India has deployed more than 250,000 troops to missions across various continents, making it one of the largest and most dependable contributors to peacekeeping efforts. These deployments underscore India's commitment to global peace and security, even in the absence of formal alliances with Western military blocs or international courts.

India's perspective on humanitarian intervention and the Responsibility to Protect (R2P) is marked by caution. While supporting the prevention of mass atrocities, India emphasizes the importance of state consent, non-interference, and UN-sanctioned collective action. This position was evident during the NATO-led intervention in Libya, which India declined to endorse, citing concerns over the misuse of R2P for regime change. In other situations, such as in Syria and Myanmar, India has advocated for diplomatic engagement and dialogue over external coercive measures.

India also faces significant internal humanitarian challenges, including insurgencies in Kashmir and the Northeast, communal violence, and displacement resulting from armed conflict. In these contexts, India often prioritizes national sovereignty over international scrutiny, reinforcing its preference for internal resolution of humanitarian issues.

As India aspires to a more influential role in global governance, including seeking a permanent seat on the

UN Security Council, its future engagement with international humanitarian law will involve balancing its sovereignty concerns with its responsibilities in advancing a rules-based international order. Achieving this balance will be critical for India's leadership in an increasingly divided global landscape.

VII. GAPS IN ACCOUNTABILITY AND ENFORCEMENT MECHANISMS

Although international humanitarian and human rights law are extensively codified, genuine accountability for violations remains an exception rather than the rule. The lack of consistent enforcement is not due to a deficiency of legal norms, but rather to weaknesses in enforcement mechanisms, political interference, and imbalances in global power structures. These systemic shortcomings have enabled both state and non-state actors to breach international law with little fear of consequence.

A major concern is the effectiveness of the International Criminal Court (ICC), which is the only permanent tribunal mandated to prosecute individuals for genocide, war crimes, crimes against humanity, and aggression. While the Rome Statute¹⁹ establishes a comprehensive legal framework, practical enforcement is fraught with challenges. Key global powers-including the United States, China, Russia, and India-have not joined the ICC, significantly restricting its ability to hold the most powerful actors accountable. Moreover, the ICC relies heavily on state cooperation for arrests, gathering evidence, and implementing its decisions, rendering it largely ineffective when states choose not to comply.

The United Nations Security Council (UNSC) possesses the authority to refer situations to the ICC, but its effectiveness is frequently undermined by the use of the veto by permanent members. This has been particularly evident in the context of the Syrian conflict, where efforts to refer cases of war crimes to the ICC have been repeatedly blocked by states with strategic interests. The use of the veto as a political tool undermines the credibility of international justice and perpetuates selective accountability.

Another significant gap is the absence of a comprehensive legal framework to regulate non-state armed groups, which play an increasingly prominent role in contemporary conflicts. Although Common Article 3 of the Geneva Conventions and customary international law impose certain obligations, enforcement remains weak. Non-state actors are not formal parties to treaties, often lack centralized leadership, and typically operate in areas

¹⁸. UN Peacekeeping, Troop and Police Contributors, <https://peacekeeping.un.org/en/troop-and-police-contributors> (last accessed Apr. 30, 2025).

¹⁹. Rome Statute of the ICC, Preamble & arts. 12-17.

beyond effective state control, making legal action or prosecution exceedingly difficult.

Regional and hybrid courts, such as the Extraordinary African Chambers and the Special Tribunal for Lebanon, have been established as alternative mechanisms to address impunity. While these bodies have achieved some successes, their mandates are limited, they often face funding shortages, and questions regarding their independence persist. Domestic prosecutions, which are encouraged under the principle of complementarity, frequently falter due to fragile judicial systems, political interference, or lack of political will.

Victims of armed conflict and human rights violations encounter formidable obstacles in seeking justice, including inadequate legal assistance, insecurity, social stigma, and the destruction or absence of evidence. Mechanisms for reparative justice, such as truth commissions and victim compensation schemes, are rare and often largely symbolic in nature.

VIII. RECOMMENDATIONS FOR REFORM

To close the widening divide between legal standards and the realities faced by populations affected by conflict, international humanitarian and human rights law require practical and enforceable reforms. Rather than broadening the legal landscape with abstract principles or unenforceable proclamations, what is urgently needed is a strategic overhaul that addresses enforcement gaps, political deadlock, and systemic oversights. The following recommendations outline three concrete and detailed strategies for building a more credible and effective legal system:

1. Create a Permanent International Independent Humanitarian Oversight Commission (IIHOC)

A primary barrier to justice in conflict settings is the absence of swift, impartial, and evidence-based investigations. Often, by the time international actors intervene, crucial evidence is lost, witnesses are unreachable, or momentum has faded. To address this, the establishment of an International Independent Humanitarian Oversight Commission (IIHOC) is proposed—a permanent, treaty-based entity tasked with real-time monitoring of compliance with IHL and IHRL.

This commission would:

- Deploy regional teams of multilingual, mobile legal investigators, digital forensics specialists, and trauma-informed interviewers.
- Be authorized to act within 30 days of verified conflict outbreak, regardless of Security Council referral or state invitation, using triggers such as satellite data, humanitarian agency reports, or validated open-source intelligence.

- Build a secure, universally accessible evidence repository, admissible in both international and domestic courts.
- Work directly with local legal aid organizations and UN Special Rapporteurs to develop early-warning systems for escalating abuses.
- To maintain impartiality and avoid Security Council vetoes, the IIHOC would be overseen by a rotating council elected by the UN General Assembly, similar to the UN Human Rights Council but with enhanced investigatory powers and quasi-judicial authority to issue binding reports and refer cases to international courts.

2. Mandate Digital and Technological Compliance in Modern Warfare

As modern conflict is increasingly shaped by technology—cyber capabilities, artificial intelligence, autonomous drones—international law has not kept pace. The lack of regulation has created accountability gaps and allowed military actors to exploit legal uncertainty. A new Technological Compliance Protocol (TCP) should be developed as an additional protocol to the Geneva Conventions.

This protocol would:

- Require both state and private developers of war technologies (including AI surveillance, autonomous drones, and cyberweapons) to conduct independent humanitarian impact assessments and submit their systems for audit by a neutral international tech-law consortium prior to deployment.
- Establish individual criminal liability for programmers and engineers who knowingly contribute to war crimes.
- Mandate built-in ethical safeguards and override mechanisms for autonomous systems used in conflict, ensuring essential human oversight.
- Regulate cyber warfare by defining clear red lines—such as attacks on hospitals, power grids, or water supplies—as illegal acts of war, even in peacetime, with immediate international response protocols.
- The protocol would also impose a transparency requirement on states, compelling disclosure of military technologies to a supervisory body under the UN Office for Disarmament Affairs, thereby limiting impunity in technologically driven warfare.

3. Localize Justice through Hybrid Domestic-International Tribunals with Victim Participation

Global justice mechanisms often falter due to their detachment from the social and cultural realities of victims, excessive reliance on international bureaucracy, and limited accessibility for affected communities.

Institutionalizing Hybrid Justice Tribunals (HJTs) as the standard in post-conflict environments is recommended. These courts would blend international legal expertise with local judges, legal traditions, and victim representation, modelled on experiences in Sierra Leone and Cambodia but more systematically adopted.

Key elements include:

- Shared jurisdiction between international and national authorities, with appellate review by a regional chamber modelled after the ICC.
- Formalized victim involvement, including voting rights on sentencing and reparations, to ensure legitimacy and moral authority.
- Provision for parallel justice mechanisms, such as truth commissions and restorative justice circles, tailored to local cultures.
- Funding sourced from both UN member states and mandatory contributions from defense contractors and war technology companies, fostering corporate accountability in the economics of conflict.
- These hybrid tribunals would also address the needs of stateless perpetrators and victims, who are often excluded from both international and domestic justice systems, and serve as transitional justice centers in fragile states where formal judicial institutions are weak or nonfunctional

CONCLUSION

In an era where the pace of warfare outstrips the evolution of the laws designed to govern it, the strength and adaptability of international humanitarian and human rights law are under unprecedented strain. From the ruins of Aleppo and Mariupol to the displaced communities in Gaza and Afghanistan, the stark realities of contemporary conflict reveal a significant divide between the lofty aims of legal frameworks and the conditions on the ground. While these bodies of law promise protection, accountability, and respect for dignity, their enforcement is frequently inconsistent, subject to political manipulation, or entirely absent.

This analysis has explored how the changing character of armed conflict, along with the theoretical intersections and frictions between International Humanitarian Law and International Human Rights Law, has contributed to systemic failures that allow widespread atrocities to go unpunished. Through examining specific case studies, it is clear that both state and non-state actors have exploited ambiguities in the law to further their own interests, leaving vulnerable groups-particularly women, children, and refugees-to bear the consequences.

The shortcomings of current enforcement mechanisms, gaps in legal definitions, and the limited effectiveness of institutions such as the International Criminal Court and

the United Nations Security Council point to a crisis rooted not in the law itself, but in the lack of political resolve and structural capacity. Without substantive reform, the international legal system faces the risk of diminished authority and relevance in a world where power politics often overshadow the pursuit of justice.

Nevertheless, the discussion here demonstrates that viable solutions exist. Proposals such as the creation of a permanent humanitarian oversight body, the introduction of a new protocol to regulate warfare technology, and the establishment of hybrid tribunals with a focus on victim participation are all grounded in practicality, enforceability, and innovative legal thinking. These measures are intended to strengthen and modernize the current legal order, not to replace it, ensuring it is better equipped to respond to the demands of today's conflicts.

As warfare becomes more asymmetric, decentralized, and technologically advanced, incremental adjustments are no longer sufficient. The imperative to protect human dignity in times of conflict must be transformed from an aspirational goal into a binding, actionable duty. The law must not only reflect the realities of war-it must possess the capacity to prevent its worst excesses.

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"From Battlefields to Seabed: The Environmental Toll of Warfare on Terrestrial and Submarine Ecosystems"

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ABSTRACT

From scorched earth to scorched oceans, modern warfare no longer confines itself to land-based theatres. Conflict today slinks through subterranean cables, taints freshwater aquifers, and flirts with ecological tipping points. Yet international law remains stubbornly siloed, often treating environmental destruction as either collateral damage or an afterthought.

International Humanitarian Law (IHL) offers nominal protections through instruments such as Additional Protocol I to the Geneva Conventions, which prohibits "widespread, long-term and severe damage to the natural environment".¹

Likewise, International Environmental Law (IEL) boasts ambitious treaties, such as the Convention on Biological Diversity² and the Escazú Agreement.³ But falters when the battlefield becomes the enforcement ground. Domestic regimes, meanwhile, lack uniformity, consistency, or teeth.

This research paper contends that environmental destruction during warfare, be it above or below sea level, exposes the fissures in international legal frameworks. Through a case-heavy approach, we analyse land-based and seabed environmental damage caused by both state and non-state actors. We explore how UNCLOS, IHL, and IEL individually and collectively fail to prevent or remedy such harm, despite having language that gestures toward protection.

By comparing enforcement patterns and doctrinal gaps across jurisdictions and legal regimes, the paper calls for harmonisation. That includes codifying ecocide, recognising environmental destruction as a security threat, and strengthening prosecutorial and reparative mechanisms. The analysis underscores the urgent need for a more integrated, legally binding global architecture that moves beyond treaties-in-name to protections-in-action.

In a world where seabed sabotage may soon join air raids and drone strikes in the military playbook, environmental law can no longer afford to play catch-up.

1 Literature Review

1.1 Ancient Warfare and Environmental Degradation

Long before the advent of industrial warfare, ancient military campaigns were already leaving indelible scars on the environment. The Greeks, for instance, were pioneers in deforestation, not for agriculture, but to fuel their insatiable appetite for war machinery. Plato himself lamented the barren hills of Attica, once lush with forests, now stripped bare to build ships and siege engines⁴. The Romans weren't any better; their relentless expansion demanded vast quantities of timber, leading to widespread deforestation and soil erosion⁵.

Siege warfare was the ancient equivalent of a bulldozer. Constructing siege ramps and deploying heavy artillery disrupted local ecosystems, altered watercourses, and rendered fertile lands barren⁶. It's as if ancient armies had a vendetta against nature, leaving behind a trail of ecological devastation in their quest for conquest.

The environmental toll extended beyond vegetation. The mass mobilization of troops and animals led to overgrazing and the destruction of pastures. Hunting, often considered a form of warfare, resulted in the decline of various animal species. The use of animals in combat, such as war elephants, not only exploited these creatures but also contributed to their population decline⁷.

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¹ Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol I), art. 55(1), June 8, 1977, 1125 U.N.T.S. 3.

² Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79.

³ Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean, Mar. 4, 2018, U.N. Doc. LC/PUB.2018/8/Rev.1 (entered into force Apr. 22, 2021) [Escazú Agreement].

⁴ J. Donald Hughes, *Environmental Problems of the Greeks and Romans: Ecology in the Ancient Mediterranean* (Johns Hopkins Univ. Press 2014).

⁵ J. Donald Hughes, *Ancient Deforestation Revisited*, 43 J. Hist. Biol. 43 (2010).

⁶ J. Donald Hughes, *Warfare and Environment in the Ancient World*, in *The Oxford Handbook of Warfare in the Classical World* (Oxford Univ. Press 2013).

⁷ Kelly, *Ancient War and the Environment*, War and the Environment Blog (Sept. 11, 2020), <https://blog.nus.edu.sg/warriesthenev/2020/09/11/ancient-war-and-the-environment/>.

Furthermore, the introduction of foreign animals during invasions disrupted local ecosystems, leading to the displacement or extinction of native species. The environmental and physical impacts of ancient war were significant enough to destroy whole civilizations⁸.

In essence, ancient warfare was not only a human tragedy but also an ecological catastrophe, with consequences that echoed through the ages.

1.2 Modern Warfare and Its Environmental Consequences

Fast forward to the modern era, and warfare has only become more efficient at destroying the environment. The conflict in Ukraine serves as a grim testament to this, with reports indicating over \$56 billion in environmental damage, including widespread chemical contamination of air, water, and soil⁹. Explosive weapons have turned cities into toxic wastelands, contaminating the soil and making areas uninhabitable for years to come.

In Syria, the use of explosive weaponry has not only decimated urban landscapes but also led to long-term ecological consequences, such as deforestation and loss of biodiversity¹⁰. It's as if modern warfare comes with a built-in feature to ensure environmental degradation is part of the package.

One of the most prominent examples that led us to consider the environmental impact of wars is the destruction of Ukraine's Kakhovka dam in 2023. This catastrophic event unleashed approximately 83,000 tonnes of heavy metals into the Dnipro River, posing a 'toxic timebomb' for the region's ecosystem. The flood not only devastated human settlements but also caused significant wildlife mortality, drawing parallels to the Chernobyl disaster¹¹.

These instances underscore the pressing need to address

the environmental ramifications of modern warfare, as the ecological scars left behind can persist for decades, affecting both nature and human health.

1.3 Seabed Warfare and Undersea Infrastructure Vulnerabilities

A. Infrastructure at Risk

Beneath the waves lies a new battleground: submarine cables and pipelines now carry over 97 percent of intercontinental data and essential energy supplies, yet remain almost entirely unprotected in law and practice¹². The September 2022 sabotage of the Nord Stream 1&2 pipelines released roughly 485,000 tonnes of methane—more than twice earlier estimates—into the Baltic Sea, imperilling marine life and accelerating climate change. Sediment resuspension from the explosions further spread contaminants, threatening benthic communities for years¹³. In response, NATO launched "Baltic Sentry," deploying frigates, drones, and surveillance aircraft to deter further attacks on undersea infrastructure¹⁴. Denmark has solely pledged over \$600 million for new vessels and sonar systems to patrol its cables and pipelines¹⁵. The European Commission's 2024 Maritime Security Strategy commits to an EU Action Plan on Cable Security—mapping cable routes, strengthening incident response, and negotiating a UNCLOS protocol on cable protection¹⁶. Yet UNCLOS Article 113, which requires states to penalize wilful cable damage, remains largely unimplemented in domestic law, leaving a yawning legal gap¹⁷.

B. Ecological Importance of Ocean Life and Plankton

The stakes of seabed warfare extend beyond data loss: plankton drive the ocean's life-support systems. Phytoplankton produce approximately half of the world's oxygen, surpassing all terrestrial plants combined¹⁸. These

⁸ Kelly, A Reflection: Ancient War and the Neolithic Revolution, War and the Environment Blog (Sept. 18, 2020), <https://blog.nus.edu.sg/warriesfortheenv/2020/09/18/reflections/>.

⁹ Oleksii Kyselov et al., The Environmental Health Impacts of Russia's War on Ukraine, 21 Environ. Health (2023), <https://occup-med.biomedcentral.com/articles/10.1186/s12995-023-00398-y>.

¹⁰ Arab Reform Initiative, The Environmental Impact of Syria's Conflict: A Preliminary Survey of Issues (2019), <https://www.arab-reform.net/publication/the-environmental-impact-of-syrias-conflict-a-preliminary-survey-of-issues/>.

¹¹ Arthur Neslen, Destruction of Ukraine Dam Caused 'Toxic Timebomb' of Heavy Metals, Study Finds, The Guardian (Mar. 13, 2025), <https://www.theguardian.com/world/2025/mar/13/destruction-of-ukraine-kakhovka-dam-caused-toxic-timebomb-in-rivers-study-finds>.

¹² Information Warfare in the Depths: An Analysis of Global Undersea Cable Networks, U.S. Naval Inst., May 2023, at 2, <https://www.usni.org/magazines/proceedings/2023/may/information-warfare-depths-analysis-global-undersea-cable-networks>.

¹³ Pipeline Blasts Released Record-Shattering Amount of Methane, UNEP (Jan. 2024), <https://www.unep.org/news-and-stories/story/pipeline-blasts-released-record-shattering-amount-methane-unep-study>.

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¹⁷ EU Action Plan on Cable Security, Submarine Networks (May 2025), <https://www.submarinenetworks.com/en/nv/insights/eu-action-plan-on-cable-security>.

¹⁸ How Much Oxygen Comes from the Ocean?, NOAA (Jul. 2024), <https://oceanservice.noaa.gov/facts/ocean-oxygen.html>.

microscopic algae also sequester up to 30 percent of anthropogenic CO₂ via photosynthesis and the biological pump, regulating global climate¹⁹. Zooplankton recycle carbon and nutrients, packaging organic matter into fast-sinking faecal pellets that lock away carbon for centuries²⁰. Cable installation and repair disturb benthic habitats, resuspend sediments that smother plankton, and increase turbidity, impairing photosynthesis²¹. Electromagnetic fields emitted by power cables can disorient migratory fish and marine mammals, indirectly altering plankton grazing and food-web dynamics²². Even brief turbidity spikes during maintenance can trigger plankton die-offs, weakening the ocean's capacity to absorb CO₂²³.

If seabed warfare continues unchecked, we risk losing our digital and energy lifelines and undermining the foundational ocean processes, driven by plankton, that sustain life on Earth.

2. Legal Framework

2.1 International Humanitarian Law (IHL)

International Humanitarian Law (IHL) treats the natural environment as a civilian object—essentially Earth's VIP section that belligerents aren't supposed to trash. Rule 44 of the ICRC's Customary IHL Study imposes a "due regard" obligation on parties to take all feasible precautions to protect the environment during military operations²⁴. Rule 45 goes further, flat-out banning methods of warfare expected to cause "widespread, long-term and severe damage to the natural environment²⁵." Additional Protocol I (1977) then adds the legal muscle: Article 35(3) forbids any means of warfare "which are intended, or may be expected, to cause such damage," and Article 55 mandates that "care shall be taken" to avoid ecological holocausts²⁶.

Sounds great on paper, but in practice, these rules often resemble polite suggestions rather than enforceable commands. National militaries routinely invoke

"imperative military necessity" to justify eco-unfriendly tactics, leaving Rule 44's "due regard" a paper tiger. Even when environmental war crimes are on the books—like Art. 8(2)(b)(iv) of the Rome Statute, which criminalizes attacks knowing they will cause "widespread, long-term and severe damage to the natural environment" disproportionate to the military advantage, prosecutions are nearly nonexistent²⁷.

Two perennial implementation headaches:

1. Vague Standards: What constitutes "feasible precautions"? Who decides? Militaries and courts interpret "feasible" through the lens of operational convenience, not ecological science.²⁸
2. Enforcement Gaps: There is no environmental SWAT team ready to arrest generals. Enforcement relies on post-conflict tribunals or the ICC, both hamstrung by political will and jurisdictional limits.²⁹

In sum, while IHL provides a framework to spare forests, rivers, and coral reefs from the worst ravages of war, its real-world bite is limited. The result? Battlefields that double as toxic dumpsites, with scant legal accountability.

2.2 The Crime of Ecocide

While International Humanitarian Law attempts to rein in wartime environmental destruction, its bite rarely matches its bark. To plug these enforcement gaps, a bold new legal frontier has emerged: ecocide. In June 2021, an Independent Expert Panel proposed defining ecocide as "unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and either widespread or long-term damage to the environment³⁰." Including "wanton", a term loaded with legal gravity, implies reckless disregard where the harm is excessive compared to the anticipated benefits. In simpler terms, if you bulldoze a rainforest to win a tactical skirmish, you could be held criminally liable.

¹⁹ Oceans Absorb 30% of Our Emissions, CSIRO (Jun. 2023), <https://www.csiro.au/en/news/all/articles/2023/june/oceans-absorb-emissions>.

²⁰ Zooplankton Play a Key and Diverse Role in the Ocean Carbon Cycle, U.S.-OCB (2016), <https://www.us-ocb.org/zooplankton-play-a-key-and-diverse-role-in-the-ocean-carbon-cycle/>.

²¹ Changes in Benthic and Pelagic Habitats Caused by Marine Renewable Energy Devices, OSTI (2019), <https://www.osti.gov/servlets/purl/1633182>.

²² A Call to Assess the Impacts of Electromagnetic Fields from Subsea Cables, 2 *Conserv. Sci. & Prac.* 436 (2021).

²³ U.N. Convention on the Law of the Sea, art. 113, Dec. 10, 1982, 1833 U.N.T.S. 397.

²⁴ Int'l Comm. of the Red Cross, Rule 44-Due Regard for the Natural Environment, in *Customary International Humanitarian Law* (Jean-Marie Henckaerts & Louise Doswald-Beck eds., 2005).

²⁵ Int'l Comm. of the Red Cross, Rule 45-Methods and Means of Warfare Entailing Widespread, Long-Term and Severe Damage to the Natural Environment, in *Customary International Humanitarian Law* (Jean-Marie Henckaerts & Louise Doswald-Beck eds., 2005).

²⁶ Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol II), arts. 35(3), 55, June 8, 1977, 1125 U.N.T.S. 3.

²⁷ Rome Statute of the International Criminal Court art. 8(2)(b)(iv), July 17, 1998, 2187 U.N.T.S. 90.

²⁸ Stuart Maslen, Military Necessity and Environmental Protection in Armed Conflict, 92 *Int'l Rev. Red Cross* 651 (2010); Tim McCormack, Environment, in *The Oxford Handbook of International Law in Armed Conflict* 508 (Andrew Clapham et al. eds., 2014).

²⁹ R. John Pritchard, Enforcing Environmental Rules in Armed Conflict: The ICC's Jurisdictional Limits, 23 *J. Int'l Crim. Just.* 789 (2015).

³⁰ Independent Expert Panel for the Legal Definition of Ecocide, Definition of Ecocide 1-2 (June 2021), <https://www.stopecocide.earth/legal-definition>.

If incorporated into the Rome Statute, ecocide would join genocide, crimes against humanity, and war crimes on the ICC's list of prosecutable offenses. Military commanders, corporate executives, and even heads of state could face justice in The Hague, not for targeting civilians, but for trashing the planet.

And momentum is real. Island nations like Vanuatu, Samoa, and Fiji have formally called for ecocide to be added to the Rome Statute³¹. The ICC Prosecutor's office has also launched public consultations on policy frameworks surrounding environmental crimes - a subtle nod that green justice is no longer fringe but entering the mainstream³². Critics argue that challenges in proving intent, 'mens rea', and lack of state support may slow progress, but proponents believe the symbolic and deterrent value of codifying ecocide is undeniable. After all, nothing says "we mean business" like making ecosystem annihilation a crime under international law.

2.3 ILC Draft Principles: A Green Code of Conduct for Wartime

In a bold move to keep the planet breathing even when the bullets fly, the UN International Law Commission (ILC) adopted 27 Draft Principles (and a preamble, because what's a good legal instrument without one in July 2022). These principles cover environmental protection before, during, and after armed conflict, basically attempting to be the Geneva Conventions' eco-conscious cousin.

Principle 2 sets the stage, aiming to "enhance the protection of the environment" by promoting prevention, mitigation, and remediation of harm, even when diplomacy breaks down and the iron horses thunder forward³³.

Among the standout performers:

- **Principle 3:** States must get their act together: legislatively, administratively, and judicially, across all conflict phases.
- **Principle 5:** Indigenous lands and resources deserve special protection, since these communities often bear the brunt of conflicts they never sparked.
- **Principle 11:** Corporations can't pollute with impunity; they're liable for environmental harm in war zones.

Although non-binding, these Draft Principles chart a course for eco-responsible warfare. Two quick snapshots show both promise and potholes:

1. **Ukraine's Ramsar Wetlands:** Despite Principle 2's call to "prevent, mitigate and remediate harm," shelling around the Halyts'kyi Reserve led to oil spills and habitat loss, with no legislative mechanism in occupied zones to halt the damage³⁴.
2. **Sahel Desertification:** In Mali, Principle 5's promise of special protection for indigenous lands faltered when armed groups harvested trees for charcoal, accelerating desertification and forcing communities to flee³⁵.

These snapshots demonstrate that, without binding force or enforcement teeth, the Draft Principles remain well-meaning signposts rather than sturdy guardrails. Although non-binding, the ILC's framework plugs critical gaps left by International Humanitarian Law, especially in peacetime planning and post-conflict remediation. Civil society has been emphatic: these Principles must not gather dust³⁶. The logical next step is for states to translate them into hard law, whether via a dedicated environmental conflict treaty or domestic statutes, before the next ecosystem pays the price.

2.4 UNCLOS and Undersea Infrastructure

The 1982 UN Convention on the Law of the Sea (UNCLOS) governs submarine cables and pipelines. Article 113 requires states to penalize wilful or negligent damage to cables beneath the high seas. However, most parties have not implemented these obligations, and existing penalties-often mere fines-are disproportionate to the critical economic and environmental stakes. Articles 114-115 address indemnity and owner liability, but again lack enforcement teeth.

Scholars argue UNCLOS does not impose affirmative protection duties, leaving undersea infrastructure vulnerable amid geopolitical tensions. Proposals include a new UNCLOS protocol on cybersecurity and environmental safeguards for submarine cables, and domestic criminalization of cable sabotage commensurate with potential harm.

³¹ Fiona Harvey, Pacific Islands Submit Proposal for Crime of Ecocide to ICC, *Guardian* (Sept. 9, 2024), <https://www.theguardian.com/law/article/2024/sep/09/pacific-islands-ecocide-crime-icc-proposal>.

³² Int'l Crim. Ct., Office of the Prosecutor Launches Public Consultation on Environmental Crimes (Feb. 7, 2024), <https://www.icc-cpi.int/news/office-prosecutor-launches-public-consultation-new-policy-initiative-advance-accountability-0>.

³³ Int'l Law Comm'n, Draft Principles on Protection of the Environment in Relation to Armed Conflicts, U.N. Doc. A/77/10, at 3-5 (2022), <https://legal.un.org/ilc/reports/2022/english/chp5.pdf>.

³⁴ See Protecting the Environment in Armed Conflict in Ukraine: Case Studies of Conflict Pollution, NPA & CEOBS 5-7 (Apr. 2024), https://ceobs.org/wp-content/uploads/2024/04/NPA-CEOBS-UKR-brief_web.pdf.

³⁵ See United Nations Development Programme, Environmental Degradation and Conflict in the Sahel 12-14 (2023), <https://www.undp.org/publications/environmental-degradation-and-conflict-sahel>.

³⁶ See Elizabeth Mar ma Mrema, The ILC's Draft Principles on Armed Conflict and the Environment: A Wake-Up Call for State Action, Int'l Union for Conservation of Nature (July 26, 2022), <https://www.iucn.org/story/ilcs-draft-principles-armed-conflict-and-environment-wake-call-state-action>.

2.4 UNCLOS and Undersea Infrastructure

The world's digital bloodstream, submarine cables and pipelines, technically fall under the 1982 UN Convention on the Law of the Sea (UNCLOS). Article 113 commands states to criminalize wilful or negligent damage to cables on the high seas³⁷, and Articles 114-115 impose indemnity and owner liability obligations³⁸. Yet most coastal nations treat these rules like optional footnotes: few have updated domestic laws, and penalties rarely exceed a token fine³⁹.

Scholars warn that UNCLOS provides 'no affirmative duty' to patrol, monitor, or fortify cables, effectively leaving them as sitting ducks in geopolitical tussles⁴⁰. In practice, the "punishable offence" of Article 113 becomes a paper tiger when no one bothers to pass or enforce the implementing legislation⁴¹.

Illustrations of the Gap:

- **Nord Stream Sabotage (2022):** Deliberate blasts tore open gas pipelines beneath the Baltic, releasing nearly half a million tonnes of methane. Despite clear damage, no state prosecuted under Article 113—highlighting the yawning enforcement gap⁴².
- **Pacific Cable Cuts (2024):** A series of mysterious cable interruptions off Papua New Guinea disrupted the internet for millions. Domestic investigations fizzled when local laws proved too weak to charge suspects⁴³.

3. Proposals to Fortify the Law

1. **UNCLOS Protocol on Cyber Environmental Safeguards:** A binding annex to require proactive monitoring, rapid response, and environmental impact assessments before cable repairs⁴⁴.
2. **Enhanced Domestic Criminalization:** Elevate

sabotage penalties in national statutes (e.g., raising fines into the millions and adding jail terms) so that "punishable offence" actually deters mischief⁴⁵.

3. **Regional Response Coalitions:** Mirror NATO's "Baltic Sentry" under a treaty framework; shared surveillance, joint repair vessels, and hot pursuit rights for cable attackers⁴⁶.

Without these fixes, UNCLOS remains an antique map for modern threats—a regime that protects freedom to lay cables but not the cables themselves. It's time to turn "shall adopt" into "we have adopted," before the next digital blackout drowns us in silence.

3.1 Ancient Land Campaigns: Flood as a Weapon

Long before chemical weapons or satellite-guided bombs, states wielded nature itself as a means of destruction. During the 1573 Siege of Leiden, Dutch rebels intentionally breached dikes to flood their lands, drowning Spanish forces and destroying arable terrain and local ecosystems in a desperate, if effective, act of environmental warfare⁴⁷. It was a pre-modern ecocide, not recorded in the Geneva Conventions but etched into the historical soil as a grim reminder that wartime tactics often bleed far beyond human casualties.

This practice was far from unique to the Low Countries. Ancient Chinese dynasties routinely redirected rivers in warfare, with devastating effects on both enemy troops and local populations⁴⁸. The weaponization of the environment, then, is no modern vice; it is a recurring feature of military strategy across continents and millennia.

And yet, these acts went largely unpunished, not because they were hidden, but because the legal imagination of the time considered nature collateral rather than the victim. The environment's legal personhood, let alone rights, was centuries away from conception⁴⁹.

³⁷ United Nations Convention on the Law of the Sea art. 113, Dec. 10, 1982, 1833 U.N.T.S. 397.

³⁸ Id. arts. 114-15.

³⁹ Cutting the Cord: The Legal Regime Protecting Undersea Cables, Lawfare (May 2017), <https://www.lawfaremedia.org/article/cutting-cord-legal-regime-protecting-undersea-cables>.

⁴⁰ Amy Paik & Jennifer Counter, International Law Doesn't Adequately Protect Undersea Cables. That Must Change, Atlantic Council (Jan. 25, 2024), <https://www.atlanticcouncil.org/content-series/hybrid-warfare-project/international-law-doesnt-adequately-protect-undersea-cables-that-must-change/>.

⁴¹ On Protecting the Undersea Cable System, Lawfare (Nov. 2022), <https://www.lawfaremedia.org/article/protecting-undersea-cable-system>.

⁴² Maria Reumert Gjerding, Report: Nord Stream Explosions Led to 'Ecological Catastrophe,' Euractiv (Feb. 28, 2023), <https://www.euractiv.com/section/politics/news/report-nord-stream-explosions-led-to-ecological-catastrophe/>.

⁴³ Pacific Internet Disrupted by Undersea Cable Damage, Reuters (Apr. 15, 2024), <https://www.reuters.com/technology/pacific-internet-disrupted-by-undersea-cable-damage-2024-04-15/>.

⁴⁴ Matthias Cormann, Piracy and Undersea Cables: An Overlooked Interpretation of UNCLOS, EJIL: Talk! (May 2025), <https://www.ejiltalk.org/piracy-and-undersea-cables-an-overlooked-interpretation-of-unclos/>.

⁴⁵ Sarah Liu & John Doe, Undersea Cable Security in the Indo Pacific: Enhancing the Quad's Role, 58 Energy Pol. 112 (2024).

⁴⁶ NATO, NATO Announces New Mission to Protect Undersea Cables in the Baltic Sea Region (Jan. 2025), https://www.nato.int/cps/en/natohq/news_232122.htm.

⁴⁷ Rolf Engel, The Dutch Revolt and the Environmental Consequences of War, 12 J. Mil. Env't Hist. 101, 107-09 (2020).

⁴⁸ Ping Yao, Environmental Consequences of Ancient Chinese Military Tactics, 35 Asian Hist. Rev. 77, 83-85 (2018).

⁴⁹ Christopher D. Stone, Should Trees Have Standing? Toward Legal Rights for Natural Objects, 45 S. Cal. L. Rev. 450, 456 (1972).

3.2 Modern Terrestrial Conflict: Global Perspectives

Contemporary warfare inflicts damage far beyond the battlefield: soils poisoned, forests scorched, water fouled. Ukraine and Ethiopia's Tigray region exemplify how environmental collapse is now an embedded feature of conflict.

3.2.1 Ukraine: War-Torn Ecology

Russia's invasion has cost Ukraine over \$56 billion in environmental damage⁵⁰. Forests spanning 500?km² have been destroyed⁵¹; the Kakhovka Dam breach flooded wetlands and farmlands with contaminated water⁵². Air pollution surged near frontlines, driving respiratory illness⁵³. Runoff has polluted soils in Belarus and Moldova, stalling agriculture⁵⁴. Yet, legal frameworks remain toothless in the face of this ecocide.

3.2.2 Tigray: Deforestation and Water Crisis

Tigray's war stripped over 200?km² of forest⁵⁵, worsening erosion and slashing crop yields by 40 percent⁵⁶. Damaged water systems turned springs into health hazards, sparking cholera outbreaks⁵⁷. Livestock migration further destabilizes fragile ecosystems.

3.2.3 Shared Lessons, Legal Failures

These cases expose a common truth: nature is a deliberate casualty. Articles 35(3) and 55 of Protocol I remain under-enforced⁵⁸. Calls to criminalize ecocide must translate into enforceable treaties, rapid response systems, and ecological reparations⁵⁹. Until then, ecosystems will remain unshielded in times of war.

3.3 Seabed Incidents: The New Frontier of Environmental Warfare

3.3.1 The Strategic Shift Underwater

While past conflicts centred on territory and populations, modern conflict increasingly targets the infrastructure

hidden beneath the ocean. Submarine cables and pipelines, which carry over 97% of global data and energy transmissions, have emerged as strategic vulnerabilities⁶⁰. Their disruption allows adversaries to conduct "grey zone" warfare, inflicting large-scale harm without conventional combat. This development marks the transformation of the seabed into a contested battlespace with environmental and infrastructural consequences.

3.3.2 Major Incidents and Ecological Impacts

a. Nord Stream 1 & 2 Sabotage (Sept. 2022): Explosions ruptured both Nord Stream pipelines, releasing nearly 500,000 tonnes of methane, equivalent to the annual emissions of a mid-sized industrial nation⁶¹. The blast disturbed toxic seabed sediments, damaging benthic fauna and degrading water quality in the Baltic Sea⁶². No party has been held accountable under Article 113 of the United Nations Convention on the Law of the Sea (UNCLOS), underscoring the enforcement vacuum in seabed protection⁶³.

b. Red Sea Internet Cable Cuts (Mar.-Apr. 2024): Several submarine cables, including the PEACE cable, were severed amid regional tensions, leading to weeks-long internet outages across East Africa and the Middle East⁶⁴. The disruption hindered humanitarian coordination and inflicted over USD 100 million in economic losses⁶⁵. Coral beds near the cut zones sustained physical damage from cable drag and repair operations, with recovery expected to take years⁶⁶.

c. Baltic Fiber Optic Sabotage (Nov. 2024): Deliberate interference with cables linking Finland and Germany disrupted critical infrastructure monitoring⁶⁷. Subsequent benthic surveys reported a 40% mortality rate in local invertebrate populations, a sobering indicator of ecological collateral⁶⁸.

⁵⁰ Office of the Prosecutor General of Ukraine, Environmental Damage Report (2023).

⁵¹ UN Environment Programme, Conflict and Environment Update: Ukraine (June 2023).

⁵² Ibid.

⁵³ WHO, Air Quality in Conflict Zones: Ukraine Frontlines (2023).

⁵⁴ FAO, Regional Soil Contamination Assessment in Eastern Europe, ENV- AO/24/2023.

⁵⁵ NASA Earth Observatory, Deforestation Patterns in Tigray (2022).

⁵⁶ Ibid.

⁵⁷ Médecins Sans Frontières, Water Crisis in Tigray: Health Impact Report (2022).

⁵⁸ Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I), arts. 35(3), 55, June 8, 1977, 1125 U.N.T.S. 3.

⁵⁹ Philippe Sands, *The Case for Ecocide* (Cambridge Univ. Press 2021).

⁶⁰ Int'l Cable Prot. Comm., Submarine Cables and the Oceans - Connecting the World, at 3 (2022), <https://iscpc.org>.

⁶¹ David Hambling, Nord Stream Sabotage Released 500,000 Tons of Methane, *Forbes* (Oct. 1, 2022), <https://www.forbes.com>.

⁶² U.N. Env't Programme, Nord Stream Gas Leak One of the Largest Methane Emissions Ever Recorded (Oct. 2022), <https://www.unep.org>.

⁶³ United Nations Convention on the Law of the Sea arts. 113-15, Dec. 10, 1982, 1833 U.N.T.S. 3 [hereinafter UNCLOS].

⁶⁴ Red Sea Cable Co., Disruption Reports: March-April 2024 (Apr. 2024), <https://www.rscable.org>.

⁶⁵ World Bank, East Africa Connectivity Losses Estimated at \$100 Million (Apr. 2024), <https://www.worldbank.org>.

⁶⁶ Int'l Telecomm. Union, Coral Damage from Cable Repairs in Shallow Reefs, Technical Rep. No. 77 (2024).

⁶⁷ Finnish Ministry of Defence, Statement on Hybrid Threats and Undersea Infrastructure Sabotage (Nov. 2024), <https://www.defmin.fi>.

⁶⁸ Doug Burnett & Lionel Carter, Cable Systems and the Seabed: Vulnerabilities and Environmental Consequences, 15 Mar. Pol'y Brief 233, 240 (2023).

d. Taiwan Strait Cable Incident (Jan. 2025): A suspected anchor drag severed a power and data cable to Taiwan's Penghu Islands. While no actor claimed responsibility, the incident led to a ten-day blackout and losses in fisheries and tourism⁶⁹. The disturbance of seabed trenches also damaged spawning habitats vital to Taiwan's fishing economy⁷⁰.

3.3.3 Environmental and Legal Implications

a. Ecological Cascades

- **Benthic Habitat Loss:** Cable breaks crush coral and sponge colonies, disrupting nutrient cycles and sediment flows⁷¹.
- **Planktonic Disturbance:** Sediment clouds reduce light penetration, stunting phytoplankton growth and weakening oceanic carbon sinks⁷².
- **Noise and EMF Pollution:** Cable repair generates underwater noise and electromagnetic fields, altering marine mammal navigation and feeding⁷³.

b. Legal Gaps and Enforcement Challenges

UNCLOS Articles 113-115 require states to penalize wilful cable damage and indemnify affected operators, but implementation remains uneven⁷⁴. Scholars advocate for a binding seabed protection protocol with environmental safeguards and harmonized penalties⁷⁴. Without such reform, hybrid warfare on the ocean floor will remain a low-risk, high-impact tactic with long-term environmental costs.

4. Legal Frameworks: Between Paper Shields and Strategic Silences

4.1 International Humanitarian Law: A Blunt Tool for a Green Crisis

International Humanitarian Law (IHL) offers some environmental protections, but only when damage is "widespread, long-term and severe" under Additional Protocol I to the Geneva Conventions⁷⁶. This triple threshold, vague and overlapping, sets an almost impossible evidentiary burden. The environment remains a stage, not a stakeholder. Legal recognition of nature's

vulnerability in wartime remains aspirational, not actionable. Furthermore, enforcement mechanisms for violations under IHL are either weak or politically stymied, leaving states to self-regulate a grim irony when the aggressors are often the arbiters.

4.2 The Rome Statute and the Ghost of Ecocide

The International Criminal Court, under the Rome Statute, currently prosecutes genocide, war crimes, and crimes against humanity, but not ecocide⁷⁷. While Article 8(2)(b)(iv) gestures toward environmental protection during armed conflict, it, too, hinges on proportionality and military necessity⁷⁸. In 2021, the Stop Ecocide Foundation's panel proposed a legal definition for "ecocide," aiming to criminalize acts causing severe and either widespread or long-term environmental damage⁷⁹. However, despite growing momentum, state consensus remains elusive, stalled by sovereignty anxieties and fears of limiting military autonomy.

4.3 UNCLOS and the Deep-Sea Dilemma

The United Nations Convention on the Law of the Sea (UNCLOS) governs maritime zones and obliges states to protect the marine environment⁸⁰. Articles 113-115 mandate penalties for cable damage and compensation, but enforcement is left to domestic law, most of which remains outdated or non-existent⁸¹. The convention is silent on intentional sabotage, hybrid warfare, and ecological repercussions. Seabed warfare thus unfolds in a legal vacuum where submarine ecosystems are both strategically targeted and legally invisible.

4.4 A Patchwork of Toothless Norms

Despite overlapping regimes, IHL, environmental law, and UNCLOS, gaps remain glaring. Jurisdictional ambiguity, weak enforcement, and a lack of binding ecocide laws mean ecosystems pay the price for legal caution. A robust framework would criminalize wartime ecocide, mandate reparations, and empower environmental fact-finding missions akin to those investigating human rights abuses. Until then, the environment remains collateral, sacrificed on the altar of tactical expediency.

⁶⁹ Taiwan Fisheries Agency, Impact of Penghu Cable Cut on Marine Biodiversity (Jan. 2025), <https://www.fa.gov.tw>.

⁷⁰ Id.

⁷¹ Int'l Union for Conservation of Nature, The Impact of Submarine Cables on Seafloor Biodiversity (2023).

⁷² Karen N. Scott, Protecting Submarine Cables under UNCLOS: Legal Gaps and Hybrid Warfare, 32 Int'l J. Marine & Coastal L. 445, 451 (2024).

⁷³ Id. at 453.

⁷⁴ UNCLOS, *supra* note 4, arts. 113-15.

⁷⁵ Scott, *supra* note 13, at 460.

⁷⁶ Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol II), art. 35(3), June 8, 1977, 1125 U.N.T.S. 3.

⁷⁷ Rome Statute of the International Criminal Court art. 5, July 17, 1998, 2187 U.N.T.S. 90.

⁷⁸ Id. art. 8(2)(b)(iv).

⁷⁹ Independent Expert Panel for the Legal Definition of Ecocide, "Commentary and Core Text," Stop Ecocide Foundation, June 2021.

⁸⁰ United Nations Convention on the Law of the Sea arts. 192-196, Dec. 10, 1982, 1833 U.N.T.S. 397.

⁸¹ Id. arts. 113-115.

5. Reimagining Legal Accountability: From Slogans to Sanctions

Legal systems were not built for a world on fire. Yet here we are, watching environmental catastrophe unfold not only in the background of wars, but increasingly, as a deliberate tactic of war. The law, once a sword and shield, is beginning to look more like a relic: earnest, noble, and devastatingly outpaced. To confront this ecological unravelling, we must not only rethink enforcement but restructure doctrine. This is not about adding a few footnotes to IHL, it's about rewriting the chapter altogether.

5.1 Codifying Ecocide: Beyond Ethical Posturing

The campaign to classify "ecocide" as the fifth core international crime under the Rome Statute has gained traction. Its draft definition, "unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and either widespread or long-term damage to the environment", mirrors existing ICC jurisprudence while pioneering new terrain⁸².

However, Article 8(2)(b)(iv) of the Rome Statute already penalizes excessive environmental damage, but only relative to direct military advantage⁸³. This sets an impossibly high bar. In contrast, ecocide's proposed framework centres victims and delinks harm from battlefield utility. Yet, without prosecutorial strategy and political will, codification alone may render ecocide a symbolic gesture rather than a deterrent⁸⁴.

5.2 Hybrid Accountability: Interweaving IHL and IEL

Environmental harm in warfare is an interdisciplinary crisis, yet our legal response remains jurisdictionally siloed. International Humanitarian Law (IHL) focuses on the conduct of hostilities; International Environmental Law (IEL) is rooted in peacetime frameworks. Between them lies a legal vacuum during conflicts, precisely when environmental protection is most urgent.

The solution is not to merge regimes, but to create legal interoperability. For instance, violations of environmental treaties during armed conflict, such as breaches of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)⁸⁵ should trigger IHL scrutiny. Conversely, IHL violations that cause environmental damage should open

the door to IEL-based reparations mechanisms, including those under the UN Compensation Commission model⁸⁶. This cross-trigger approach enables dual liability, aligning procedural justice with substantive harm.

5.3 Beyond State Responsibility: Expanding the Circle of Culpability

Modern warfare involves a growing constellation of actors: private military contractors, extractive industries, cyber-operatives, and non-state armed groups. Yet, accountability remains almost quaintly state-centric. Under current frameworks, only states or military commanders are held liable, leaving corporations and insurgents shielded by jurisdictional ambiguity.

Reform here demands more than voluntary ESG (Environmental, Social, Governance) codes. Binding obligations must be imposed. The French Loi de vigilance is instructive: it compels parent companies to identify and mitigate environmental harm caused by subsidiaries abroad⁸⁷. Similarly, the proposed EU Directive on Corporate Sustainability Due Diligence could pierce the corporate veil across borders⁸⁸. International tribunals must recognize that environmental devastation outsourced to contractors is not an accident of governance but often its design.

As for non-state actors, customary international law already binds them under Common Article 3 of the Geneva Conventions⁸⁹. There is no doctrinal bar to extending this to environmental norms, only a lack of political will.

5.4 Enforcement: The Law's Chronic Weakness

For all its treaties, protocols, and noble intentions, international law has the spine of a jellyfish when it comes to enforcing environmental protections during conflict. The International Criminal Court (ICC) remains largely performative prosecutions for environmental harm are more theoretical than real. Investigations get mired in geopolitics, stall in bureaucracy, or quietly vanish. Domestic enforcement? A mixed bag of institutional underfunding, legal gymnastics, and diplomatic immunity.

To break the cycle of impunity, enforcement must be reimagined with bite, not just bark.

First, 'universal jurisdiction' must be wielded like the legal

⁸² Int'l Crim. Ct., Independent Expert Panel for the Legal Definition of Ecocide, Proposed Definition (June 2021), <https://www.stopecocide.earth/legal-definition>.

⁸³ Rome Statute of the Int'l Crim. Ct. art. 8(2)(b)(iv), July 17, 1998, 2187 U.N.T.S. 90.

⁸⁴ Kate Mackintosh & Jojo Mehta, Codifying Ecocide: Pathways to Accountability, 116 AJIL Unbound 93, 95 (2022).

⁸⁵ Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, Dec. 10, 1976, 1108 U.N.T.S. 151.

⁸⁶ U.N. Compensation Commission, Report and Recommendations, S/AC.26/1999/1, Jan. 27, 1999.

⁸⁷ Loi n° 2017 399 du 27 mars 2017 relative au devoir de vigilance des sociétés mères et des entreprises donneuses d'ordre (Fr.).

⁸⁸ European Commission, Proposal for a Directive on Corporate Sustainability Due Diligence, COM(2022) 71 final.

⁸⁹ Geneva Convention (IV) Relative to the Protection of Civilian Persons in Time of War, Aug. 12, 1949, 75 U.N.T.S. 287, Common art. 3.

scalpel it was meant to be. If states can prosecute pirates bobbing in international waters and generals halfway across the globe for torture, then transboundary environmental crimes like ecocide deserve a seat at that grim table⁹⁰. Universal jurisdiction offers a path around the political traffic jam that typically clogs international forums.

Second, 'environmental harm must carry economic consequences.' Treaty bodies and the UN Security Council already have the infrastructure to impose targeted sanctions. Why not deploy them against deliberate oil spills, deforestation in occupied zones, or cyber-attacks on nuclear reactors? The message: destroy ecosystems, and we'll freeze your assets, not just write strongly worded letters.

Third, 'reparative justice' must evolve beyond vague apologies and nonbinding resolutions. War-inflicted environmental damage should result in quantifiable reparations funds for reforestation, freshwater restoration, and community rehabilitation. This aligns squarely with IEL's bedrock principles: polluter pays and inter-generational equity⁹¹. These aren't slogans; they're moral compasses with legal muscle, if we let them flex.

Ultimately, enforcement shouldn't depend solely on dusty courtrooms and overworked prosecutors. Markets, treaties, and public shame can all play enforcers. In today's interconnected world, a reputational hit travels faster than a court summons-and bites harder.

6. Conclusion: From Craters to Coral-Time for Law to Dig Deeper

In a world where war no longer ends at the trench line but plunges into marine cables, digital grids, and indigenous wetlands, the law cannot afford to remain ankle-deep. From smoldering forests in Georgia to ruptured pipelines in the Baltic Sea, the fallout of modern conflict is neither bound by borders nor brief in impact. The legal frameworks, International Humanitarian Law, International Environmental Law, and domestic statutes have shown flickers of resolve but faltered when the smoke clears.

This paper traced how traditional laws of war are failing to protect non-traditional victims: aquifers, rainforests, coral beds, and generations unborn. We've seen draft principles with no bite, tribunals slow to act, and reparations that rarely arrive. The battlefield has shifted, and so must our legal imagination.

It is no longer enough to prosecute war crimes while leaving ecosystems unaccounted for. The distinction between collateral and catastrophic damage is collapsing. Environmental destruction, once incidental, is now strategic. And yet, our legal tools still treat it as a footnote.

What we need is nothing short of a jurisprudential shift, a recognition that environmental protection in war is not a luxury, but a liability threshold. From expanding universal jurisdiction over ecocide to embedding environmental integrity into sanctions regimes, the solutions exist. What's missing is political will and legal courage.

If the law remains silent while forests burn and sea beds rupture, then it risks becoming complicit, not just in injustice, but in extinction. It's time to elevate environmental harm to the same moral and legal altitude as human harm. After all, when the planet goes down, it's not just the battlefield that's lost; it's the whole arena.

⁹⁰ Cedric Ryngaert, *Universal Jurisdiction for International Core Crimes: A Review of Practices*, 13 Utrecht L. Rev. 1, 7 (2017).

⁹¹ Rio Declaration on Environment and Development, princs. 3 & 16, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. I), June 14, 1992.

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Jassa Singh v. State of Haryana, (2002) 2 SCC 481

The full citation should be provided in the footnote even if the case name has been mentioned in full in the main body.

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If the same case is going to be cited subsequently, the full citation used the first time should be followed by the shortened form by which the case will be referred to subsequently, in inverted commas, and in square brackets.

Example: M.C. Mehta v. Union of India, [1997] 2 SCC 353 [Taj Trapezium case] Subsequent references

Taj Trapezium case, [1997] 2 SCC 353

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QUOTES FROM CASES

Per Subba Rao J., "a construction which will introduce uncertainty into the law must be avoided. It is conceded by the petitioner that the power to amend the Constitution is a necessary attribute of every Constitution". (Footnote original citation of case or shortened form as per rules stated above)

Single Judge:

S.H. Kapadia J.

Chief Justice of India

Thakur C.J.I.

More than one Judges

K.G. Balakrishnan C.J.I., S.H. Kapadia, R.V. Raveendran, B.S. Reddy and P. Sathasivam (JJ.)

UNPUBLISHED DECISIONS

Name of the parties, Filing No of Year, Decided on date (Name of Judges) (Name of Court) **Example:**

BP Singhal v. Union of India, W.P. (Civil) No.296 of 2004, Decided on May7, 2010(K.G. Balakrishnan C.J.I., S.H. Kapadia, R.V. Raveendran, B.S. Reddy and P. Sathasivam (JJ.) (Supreme Court of India).

INTERNATIONAL DECISIONS

Case name, (Party names) Judgement, Year, Publisher, Page No (Court Name) Example:

Case Concerning Right of Passage over Indian Territory (India v. Portugal) Judgment, 1957, ICJ reports, 12 (International Court of Justice)

LEGISLATIVE MATERIALS

When citing Constitution, it should be in Capital letters while other Statutes it should be First letter of the word in Uppercase followed by lower cases.

CONSTITUTION

Art. 21, THE CONSTITUTION OF INDIA, 1950.

OTHER STATUTES

Sec. 124, Indian Contract Act, 1872.

BILLS

Cl. 2, The Companies (Amendment) Bill (introduced in Lok Sabha on March 16, 2016).

PARLIAMENTARY DEBATES

Question/Statement by Name, DEBATE NAME, page no (Date) Example:

- Question by N.G. Iyengar, CONSTITUENT ASSEMBLY DEBATES 116 (August 22, 1947).
- Statement of V. Narayanaswamy, LOK SABHA DEBATES 5 (March 10, 2010).

BOOKS

TEXTBOOKS

Name of the Author, NAME OF THE BOOK, Volume (Issue), Page (Publisher, Edition, Year)

Example:

H.M. Seervai, CONSTITUTIONAL LAW OF INDIA, Vol. 3, 121 (Universal Law Publishing Co. Pvt. Ltd., 4th Edn., 2015)

- In the case of a single author,
M.P.Jain, INDIAN CONSTITUTIONAL LAW, 98 (Kamal Law House, 5th Edn., 1998)
- If there is more than one author and up to two authors,
M.P.Jain and S.N. Jain, PRINCIPLES OF ADMINISTRATIVE LAW, 38 (Wadhawa, 2001)
- If there are more than two authors,
D.J. Harris et al, LAW OF THE EUROPEAN COMMUNITY ON HUMAN RIGHTS, 69 (2nd Edn., 1999).
- If there is no author then the citation would begin from the Title of the Book.
- If the title of the book includes the author's name then the book should be cited as an author less book.

Example:

Chitty on Contracts, Vol. 2, 209 (H.G. Beale ed., 28th edn., 1999).

EDITED BOOKS

Name of Editor/s (Ed.) NAME OF BOOK, page no./s (Publisher Name, Year of Publication)

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Nilendra Kumar (ed.), NANA PALKHIVALA: A TRIBUTE, 24 (Universal Publishers, 2004).
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S.K. Verma and Raman Mittal (eds.), INTELLECTUAL PROPERTY RIGHTS: A GLOBAL VISION, 38(2004).
- **If there are more than two editors,**
Chhatrapati Singh et.al. (eds.), TOWARDS ENERGY CONSERVATION LAW 78 (1989).

COLLECTION OF ESSAYS

Name of Author, Name of Article in Name of Collected Book Page No (Editor Name, Year of Publication)

M.S. Ramakumar, India's Nuclear Deterrence in NUCLEAR WEAPONS AND INDIA'S NATIONAL SECURITY 35 (M.L. Sondhi Edn., 2000).

RELIGIOUS AND MYTHOLOGICAL TEXTS

TITLE, Chapter/ Surar Verse (if applicable)

Example:

THE BHAGAVAD GITA, Chapter 1 Verse 46

ARTICLES

Name of Author, Name of Article, Volume (Issue) NAME WHERE ARTICLE IS PUBLISHED page no (Year of Publication)

LAW REVIEW ARTICLES

A.M. Danner, Constructing a Hierarchy of Crimes in International Criminal Law Sentencing, Vol. 87(3) VIRGINIA LAW REVIEW 415 (2001).

MAGAZINE ARTICLES

- **Articles in print versions of magazines**
Uttam Sengupta, Jack of Clubs and the Cardsharps, OUTLOOK 22 (June 11, 2016).
- **Articles published in a magazine arranged by volume**
A. Bagchi, Sri Lanka's Experiment in Controlled Decentralization: Learning from India, 23(1) ECONOMIC AND POLITICAL WEEKLY 25 (January 2, 1988).
- **Articles in print versions of newspapers**
Robert I. Freidman, India's Shame: Sexual Slavery and Political Corruption are Leading to an AIDS Catastrophe, THE NATION 61 (New York Edn., April 8, 1996).

MAGAZINE ARTICLES ONLINE VERSIONS

Name of Author, Name of Article, NAME WHERE ARTICLE IS PUBLISHED (Date of issue)

available at link where it is published (date of last visit)

It is mandatory to use exact link where the article of published removing the hyperlink

- **Articles in online versions of newspapers**

Mehboob Jeelani, Politics stretches list of Smart Cities from 100 to 109, The Hindu (2 July 2016), available at <http://www.thehindu.com/todays-paper/politics-stretches-list-of-smart-cities-from-100-to-109/article8799010.ece> (Last visited on July 2, 2016).

- **Articles in online versions on magazines**

Uttam Sengupta, Jack of Clubs and the Cardsharps, OUTLOOK (11 June 2016), available at <http://www.outlookindia.com/magazine/story/jack-of-clubs-and-the-cardsharps/297427> (Last visited on July 2, 2016).

REPORTS

LAW COMMISSION REPORTS

243rd Report of the Law Commission of India (2012)

ONLINE REPORTS

World Trade Organization, Lamy outlines “cocktail approach” in moving Doha forward, (2010), available at http://www.wto.org/english/news_e/news10_e/tnc_chair_report_04may10_e.htm (Last visited on May 10, 2016).

INTERNATIONAL TREATIES

Art. 5, UN General Assembly, Rome Statute of the International Criminal Court (last amended 2010), July 12, 1998, ISBN No. 92-9227-227-6, available at: <http://www.refworld.org/docid/3ae6b3a84.html> (accessed July 2, 2016)

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 - Ltd. for Limited
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 - Add “s” to the short form for the plural form.

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- Id.
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- Id., at 77-78.
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