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AI-ing the Future: An Analysis of Past Treaty Features in Regulating Innovative Technologies

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AI-ing the Future: An Analysis of Past Treaty Features in Regulating Innovative Technologies

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Abstract

This thesis examines the relationship between the specific features written into multilateral treaties and their success in regulating innovative technologies. It explores why detailed treaty provisions such as periodic reviews, trigger mechanisms, amendment provisions, and knowledge sharing are critical to the effectiveness of these international agreements. I argue that the presence of these features contributes significantly to a treaty's ability to adapt to changing circumstances, ensure transparency, and facilitate ongoing cooperation and collaboration among signatories. To test this claim, I completed an in-depth case study analysis of technologies like railroads, telegraphs, electricity, and nuclear weapons. The findings indicate that treaties incorporating these dynamic features are better equipped to prevent negative outcomes and promote positive advancements. Specifically, the analysis shows a correlation between these features and successful outcomes, as evidenced by their capacity to reduce human harm and minimize unfair gains among participating nations. This argument is significant because it suggests a blueprint for drafting future treaties that can effectively manage the complex challenges posed by rapid technological changes. The study's insights are instrumental for policymakers aiming to harness the benefits of global technological progress while mitigating its potential risks to humans.

I. Introduction

Artificial intelligence (AI) is like giving computers a brain that can think and solve problems like humans. In 1956, it was first defined as "the science and engineering of making intelligent machines[1]." Throughout several decades of the 20th century, we have seen AI evolve progressively into intelligent machines and algorithms that can "reason and adapt based on sets of rules and environment which mimic human intelligence[2]." Machine learning and deep learning are key subsets of AI, where algorithms are designed to learn and improve from experience without explicit programming[3]. From these key subsets, AI has significantly evolved, with generative AI models now able to produce content that mimics human-like creations across various domains, including text, images, and speech. These advancements have not only expanded the capabilities of AI but have also raised important discussions on ethics and the responsible use of AI technologies[4]. Currently, the use of AI has spread across many industries, such as "business, science, art, and education," to enhance user experience and improve efficiency[5]. Applications of AI exist in many parts of everyday life. You see it being used in smart home appliances, smartphones, Google, and Siri[6]. Given this, the general population is familiar with and uses this artificial intelligence on an everyday basis. Yet there is a lack of

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[1] McCarthy, J. (n.d.). What is AI? Stanford University. http://jmc.stanford.edu/articles/whatisai/whatisai.pdf
[2] McCarthy, J. (n.d.). What is AI? Stanford University. http://jmc.stanford.edu/articles/whatisai/whatisai.pdf
[3] IBM. (n.d.). Artificial intelligence. IBM. https://www.ibm.com/topics/artificial-intelligence
[4] IBM. (n.d.). Artificial intelligence. IBM. https://www.ibm.com/topics/artificial-intelligence
[5] Ng, D. T. K., Leung, J. K. L., Chu, K. W. S., & Qiao, M. S. (2021). AI Literacy: Definition, Teaching, Evaluation and Ethical Issues. *Proceedings of the Association for Information Science and Technology*, 58(1). https://doi.org/10.1002/pra2.487
[6] Ng, D. T. K., Leung, J. K. L., Chu, K. W. S., & Qiao, M. S. (2021). AI Literacy: Definition, Teaching, Evaluation and Ethical Issues. *Proceedings of the Association for Information Science and Technology*, 58(1). https://doi.org/10.1002/pra2.487

understanding about the underlying concepts, technologies, and potential ethical concerns associated with using this artificial intelligence[7].

As we navigate through the historical timeline and advancements of artificial intelligence, it becomes apparent that while AI enhances our daily experiences, it also introduces complex challenges that necessitate careful management. Policymakers are faced with the challenge of regulating this rapidly evolving and impactful technology. My thesis aims to demonstrate that while regulating AI appears challenging, it is not entirely uncharted territory and without precedent. History has shown that AI is another instance in a long line of technological innovations that society has successfully adapted to and regulated. By studying past inventive technologies that are the same kind and degree, like the railroad, telegraph, nuclear weapons, and electricity, I aim to uncover the underlying features in their multilateral treaties that correlate to their successful regulation.

My thesis is driven by understanding how agreements play a role in shaping technology agreements. Drawing from these historical precedents, I seek to identify the elements that have enabled certain regulatory frameworks to mitigate harm effectively. This analysis is important because it goes beyond the establishment of multilateral treaties and instead explores how these agreements can be crafted to foster better outcomes. By dissecting the nuances of historical contracts and treaties, this study demonstrates the correlation between certain features and how they link to successful regulatory outcomes. As a future lawyer, I am compelled by the desire to

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[7] Ng, D. T. K., Leung, J. K. L., Chu, K. W. S., & Qiao, M. S. (2021). AI Literacy: Definition, Teaching, Evaluation and Ethical Issues. *Proceedings of the Association for Information Science and Technology*, 58(1). https://doi.org/10.1002/pra2.487

understand how well-crafted contracts can potentially mitigate the risks associated with revolutionary technologies like AI.

The subsequent chapters of this thesis will not only detail the case studies but also discuss the broader implications of these findings. Through a meticulous examination of historical data, I will demonstrate that while contracts are not the end-all, they are an essential tool for policymakers aiming to regulate complex, innovative technologies like artificial intelligence effectively. I found that there is compelling evidence gathered from historical precedents that links these regulatory approaches to success. It becomes clear that such regulatory frameworks do not merely act as just constraints but can serve as catalysts for responsible innovation. By setting clear guidelines and standards, regulators have already shown a correlation to how to create agreements that facilitate innovation while ensuring public safety and ethical compliance. This then makes it possible to harness the benefits of technological innovations like AI while minimizing their potential risks to society. As someone who aspires to shape and influence the future of technology policy, I recognize the importance of drawing on historical insights to address contemporary challenges. The lessons learned from past technological regulations reveal not only possible pitfalls but also strategies that have correlated to successful outcomes. Studying these patterns helps cultivate a nuanced appreciation of how laws and contracts can be designed to protect society while also promoting technological advancement.

I begin this study by offering a comprehensive background on artificial intelligence, focusing on the problems associated with AI and why policymakers are having such trouble regulating it. I then discuss my different variables and define key characteristics associated with my thesis. I consider the different types of treaties to utilize and explain why I chose multilateral

treaties over bilateral treaties. I also define my theory of regulation and success, which I will prove in my thesis. I then move into my case studies to utilize different innovative technologies that relate by the same kind and degree to artificial intelligence. I quantify my predictions and explore the linkage between treaty features and effective regulation. Finally, I will conclude by showing how this is crucial for crafting policies that not only address the immediate impacts of AI but also anticipate and mitigate future challenges, thus ensuring that regulation keeps pace with innovation.

II. Literature Review

A. Innovative Technology Overview

1. Defining Innovative Technology

The term 'innovation' originates from the Latin 'innovatio', which means "the entry of a new into a certain sphere[8]." First used in the mid-17th century, the term highlights how innovation involves not just introducing something new but also integrating this novelty into existing frameworks to bring about significant changes[9]. Innovation is both a process of renewal and an activity of implementing and cultivating new ideas within social practices. The complete development of innovative activities encompasses several interrelated types of work: research activities (both discovery and invention), project activities (applying scientific knowledge

[8] Tosheva, N., & Abdullaeva, G. (2022). The concept of "Innovation" and types of innovative technologies. *Scientific Progress*, 3(3). Retrieved from https://cyberleninka.ru/article/n/the-concept-of-innovation-and-types-of-innovative-technologies/viewer

[9] Tosheva, N., & Abdullaeva, G. (2022). The concept of "Innovation" and types of innovative technologies. *Scientific Progress*, 3(3). Retrieved from https://cyberleninka.ru/article/n/the-concept-of-innovation-and-types-of-innovative-technologies/viewer

practically), and educational activities (developing professional and personal knowledge for implementation)[10]. This influence allows human activity to not only solve existing problems but also to create new ways of interacting with the world and each other[11]. The shift towards innovative educational technologies, for example, reflects a move towards "systems that promote self-development and the full engagement" of participants in their own learning processes[12]. Together, this creates a comprehensive ecosystem that fosters continual growth and adaptation in the face of evolving technological and societal needs.

A. Characteristics of Innovative Technologies

Innovative technologies are distinguished by several key characteristics that drive their transformative impact across industries. First, they possess a disruptive nature, challenging and changing the status quo by replacing outdated norms and standards[13]. This disruption often results in significant paradigm shifts within the sector, redefining what is possible and expected. Secondly, scalability is a fundamental attribute of these technologies. They are designed to be expanded or enhanced to meet growing demands, allowing their benefits to reach larger

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[10] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

[11] Tosheva, N., & Abdullaeva, G. (2022). The concept of "Innovation" and types of innovative technologies. *Scientific Progress*, 3(3). Retrieved from https://cyberleninka.ru/article/n/the-concept-of-innovation-and-types-of-innovative-technologies/viewer

[12] Tosheva, N., & Abdullaeva, G. (2022). The concept of "Innovation" and types of innovative technologies. *Scientific Progress*, 3(3). Retrieved from https://cyberleninka.ru/article/n/the-concept-of-innovation-and-types-of-innovative-technologies/viewer

[13] Nagy, S., & Kobielieva, A. (2021). Theoretical and methodological essence of innovative technology. *MIND Journal*, 12(2021), Article 1. https://doi.org/10.36228/MJ.12/2021.1

populations and cover broader geographical areas[14]. Lastly, innovative technologies typically emerge from the intersection of various scientific and technological fields, embodying an interdisciplinary nature[15]. This convergence integrates diverse knowledge bases, enabling the creation of comprehensive and multifaceted solutions that address complex problems in novel ways. These characteristics collectively contribute to the harmful transformative potential of innovative technologies.

B. Defining Artificial Intelligence

Artificial intelligence is a prime example of innovative technology that not only embodies advancement but also revolutionizes how we interact with the world around us. This innovative technology is in the process of reshaping our approach to problem-solving and decision-making across various sectors. Artificial Intelligence (AI), a term coined by Stanford Professor John McCarthy in 1955, was defined as "the science and engineering of making intelligent machines[16]." This definition underscores the foundational goal of AI: to create systems that can perform tasks that would typically require human intelligence. These tasks include learning, reasoning, problem-solving, perception, and understanding language[17]. Moreover, as artificial intelligence grows more sophisticated, it is beginning to challenge our

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[14] Srivastava, D. (2023, April 14). Balancing innovation and regulation: The role of technology policy in the digital age.
[15] Nagy, S., & Kobielieva, A. (2021). Theoretical and methodological essence of innovative technology. *MIND Journal*, 12(2021), Article 1. https://doi.org/10.36228/MJ.12/2021.1
[16] Manning, C. (2020, September). Artificial Intelligence Definitions. Stanford University Human-Centered Artificial Intelligence. Retrieved from https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf
[17] Manning, C. (2020, September). Artificial Intelligence Definitions. Stanford University Human-Centered Artificial Intelligence. Retrieved from https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf

conventional views on what machines are capable of achieving. This ongoing advancement led to innovations such as autonomous vehicles, personalized medicine, and smart city technologies, all of which have the potential to alter our societal landscape drastically.

C. Problems with AI

Artificial intelligence (AI) is often celebrated as the forerunner of a new era in technology, driving innovations that promise to reshape the world. Yet, the rapid evolution of AI systems, especially in making decisions affecting human lives, has sparked intense debates on their governance and ethical implications[18]. Autonomous and intelligent systems are no longer confined to benign applications; they are making critical decisions in sensitive areas like hiring, credit scoring, criminal justice, and beyond[19]. This raises profound questions about the generation of misinformation, the erosion of privacy, and the potential for systemic biases, leading to societal upheaval and questioning the underpinnings of fairness and justice.

AI, in its "unbridled state, can serve as a tool for unprecedented control and manipulation," necessitating a comprehensive regulatory framework to harness its potential while safeguarding against its dangers[20]. Unregulated AI use poses multifaceted problems,

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[18] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

[19] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

[20] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world

including “ethical dilemmas, privacy infringements, and decision-making biases[21].” These challenges are not only technical but also societal, affecting democracy, equity, and the global power balance[22]. For example, AI's role in spreading disinformation has been widely recognized, impacting political processes and public trust[23]. Moreover, AI's decision-making processes in hiring or law enforcement can perpetuate biases, leading to unfair treatment based on race, gender, or other characteristics[24]. Privacy concerns also loom large, with AI's capability to analyze vast datasets, sometimes without consent, leading to potential surveillance and privacy invasions.[25] The pervasive integration of AI into daily life has been so seamless that its underlying complexities and potential for misuse often remain obscured, evoking the need for some type of regulation. Governments and policymakers worldwide are grappling with these challenges, seeking to strike a balance between fostering innovation and mitigating the risks that AI poses to ethical norms and human rights.

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[21] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

[22] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

[23] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world

[24] Baldwin, R., & Cave, M. (2020). Positive regulation and success. In *Taming the Corporation: How to Regulate for Success* (pp. 15-C2.P57). Oxford University Press. https://doi.org/10.1093/oso/9780198836186.003.0002

[25] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee. Retrieved from https://ieeeusa.org/assets/public-policy/committees/aipc/How-Should-We-Regulate-AI.pdf

D. Struggles of Policymakers in Regulating AI

Policymakers worldwide are grappling with regulating rapidly advancing artificial intelligence. This task is complex due to AI's inherent complexity, dynamic evolution, and the significant impacts it can have on society.

One primary hurdle is the lack of consensus on what constitutes AI[26]. The expansive nature of AI definitions can encompass "everything from simple automated calculations to advanced machine learning systems," leading to debates and confusion over the scope of regulation[27]. Policymakers must balance between overly broad definitions that stifle innovation and narrowly focused ones that might miss significant emerging risks. This struggle was evident when New York City's Automated Decision Systems Task Force on AI initially aimed to regulate the city's use of automated decision systems but ended up narrowly focusing on defining the term itself[28]. Established by the New York City Council, the task force was designed to address the city's growing use of artificial intelligence. However, it encountered significant challenges in defining the scope of what constitutes "automated decision systems.[29]." The task force faced difficulties in reaching a consensus on the definition, with debates arising over how broad or narrow this definition should be[30]. For example, during one hearing, a city agency contended that

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[26] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/
[27] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/
[28] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/
[29] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/
[30] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

the task force's proposed definition was so expansive it could include basic computational operations, like spreadsheet formulas, which are not typically considered AI[31]—this debate over definitions led to a narrowing of the task force's ambitions. Instead of producing comprehensive guidelines or regulations for the city's use of automated decision systems, the group's efforts became focused primarily on defining the types of systems that should be under oversight[32]. As a result, the task force's final output was more limited in scope than originally intended, highlighting the complexity and challenges of regulating AI technologies.

The rapid pace of technological innovation in AI, often referred to as the "pacing problem," presents another major challenge[33]. This issue arises when the speed of technological advancement outstrips the regulatory response, leading to outdated or irrelevant policies[34]. Policymakers struggle to keep up with the continuous and fast-paced evolution of AI technologies, from advancements in generative machine learning to the widespread application of AI in various sectors[35]. Furthermore, the velocity of AI development, known as the “Red

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[31] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[32] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[33] Thierer, A. (2018, August 8). The pacing problem and the future of technology regulation: Why policymakers must adapt to a world that's constantly innovating. Mercatus Center. Retrieved from https://www.mercatus.org/economic-insights/expert-commentary/pacing-problem-and-future-technology-regulation

[34] Thierer, A. (2018, August 8). The pacing problem and the future of technology regulation: Why policymakers must adapt to a world that's constantly innovating. Mercatus Center. Retrieved from https://www.mercatus.org/economic-insights/expert-commentary/pacing-problem-and-future-technology-regulation

[35] Thierer, A. (2018, August 8). The pacing problem and the future of technology regulation: Why policymakers must adapt to a world that's constantly innovating. Mercatus Center. Retrieved from

Queen problem," where "species or populations" must move faster just to maintain the same position, further complicates regulatory efforts[36]. The "Red Queen problem" in the context of AI development and regulation refers to the scenario where regulators must continuously accelerate their efforts just to keep pace with the rapid advancements in AI technology[37]. This metaphor, drawn from Lewis Carroll's "Through the Looking Glass," aptly describes the challenge faced by policymakers in managing the velocity of AI's evolution. AI's rapid evolution from niche technical applications to mainstream consumer products necessitates a regulatory framework that is both focused and agile, capable of adapting to the quick shifts in technology and its societal impacts[38]. The introduction of highly capable AI systems, like ChatGPT-3 by OpenAI, exemplifies this rapid development, moving AI into the spotlight and making it accessible to the general public. These advancements have triggered a competitive race among major tech companies, each striving to integrate and capitalize on the latest AI capabilities, which further accelerates the pace of development[39]. This swift progression presents a significant challenge for regulatory bodies. Traditional regulatory frameworks, designed in a slower-moving industrial era, lack the flexibility and responsiveness needed to manage the dynamic nature of AI

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https://www.mercatus.org/economic-insights/expert-commentary/pacing-problem-and-future-technology-regulation

[36] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[37] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[38] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[39] O'Shaughnessy, M. (2022, October 6). One of the biggest problems in regulating AI is agreeing on a definition. Carnegie Endowment for International Peace. Retrieved from https://carnegieendowment.org/2022/10/06/one-of-biggest-problems-in-regulating-ai-is-agreeing-on-definition-pub-88100

technology effectively. As AI continues to evolve and integrate into various aspects of daily life, the need for an agile and focused regulatory approach becomes increasingly critical.

In addition, AI's diverse applications and impacts mean that it permeates various sectors, each with its unique risks and regulatory needs[40]. Policymakers must discern between AI applications that warrant strict regulation, like those affecting critical infrastructure or posing significant ethical concerns, and those where regulation might be less stringent. This differentiation requires a nuanced understanding of AI's broad spectrum of applications and their potential societal consequences.

E. Proposed AI Suggestions

The development of artificial intelligence (AI) has prompted significant discussions around the need for effective regulatory frameworks. As highlighted by various sources, the approach to AI regulation is a global concern, with regions like the EU implementing extensive rules and others like the U.S. adopting a more decentralized strategy[41]. The EU's AI Act, for instance, uses systems-based risk levels and imposes stringent controls on higher-risk applications, aiming to balance innovation with public safety. [42] This comprehensive framework classifies AI systems into four distinct risk categories, each subject to varying degrees of

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[40] O'Shaughnessy, M. (2022, October 6). One of the biggest problems in regulating AI is agreeing on a definition. Carnegie Endowment for International Peace. Retrieved from https://carnegieendowment.org/2022/10/06/one-of-biggest-problems-in-regulating-ai-is-agreeing-on-definition-pub-88100

[41] Galindo, L., Perset, K., & Sheeka, F. (2021, August 3). An overview of national AI strategies and policies. *OECD*. https://doi.org/10.1787/ec5958b3-en

[42] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

regulatory oversight[43]. AI applications that pose clear threats to individual safety, livelihoods, or rights, such as manipulative social scoring systems, are categorized as presenting an "unacceptable risk" and are outright banned[44]. For "High-risk" AI systems, such as those used in healthcare, transportation, and public infrastructure, require rigorous assessments before deployment[45]. These systems must undergo thorough testing for safety and bias, maintain extensive documentation, and meet strict standards for transparency and accountability[46]. AI applications that interact directly with users, like chatbots or job application tools, are classified under "limited risk[47]." They must clearly disclose their AI-driven nature to ensure users are aware they are interacting with machines, thus allowing them to make informed decisions[48]. Meanwhile, AI systems deemed to pose "minimal risk" face the least regulatory constraints and are encouraged to adhere to voluntary codes of practice to promote trust and integrity[49]. Furthermore, the AI Act stipulates that all high-risk AI applications must undergo a conformity assessment to verify compliance with the act's stringent requirements before they can enter the

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[43] Wörsdörfer, M. The E.U.'s artificial intelligence act: an ordoliberal assessment. *AI Ethics*(2023). https://doi.org/10.1007/s43681-023-00337-x

[44] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

[45] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

[46] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

[47] Schwemer, S. F., Tomada, L., & Pasini, T. (2021, June 21). Legal AI systems in the EU's proposed Artificial Intelligence Act. In *Proceedings of the Second International Workshop on AI and Intelligent Assistance for Legal Professionals in the Digital Workplace (LegalAIIA 2021)*, held in conjunction with ICAIL 2021 (pp. 1-8). São Paulo, Brazil.

[48] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

[49] Wörsdörfer, M. The E.U.'s artificial intelligence act: an ordoliberal assessment. *AI Ethics*(2023). https://doi.org/10.1007/s43681-023-00337-x

market[50]. This assessment must be renewed periodically to ensure continuous compliance[51]. For AI systems developed or deployed outside the EU but used within its borders, the act mandates the designation of a legal representative within the EU to ensure adherence to the regulations[52].

While groundbreaking, the EU's AI Act encounters several challenges that could impact its effectiveness. One major issue is the complexity of its implementation, which involves defining AI systems and categorizing them according to risk. This process can be "technically challenging" and may result in ambiguities that complicate enforcement efforts[53]. Additionally, the stringent regulations imposed on high-risk applications might inadvertently stifle innovation by imposing burdensome compliance requirements and periodic assessments that could deter startups and smaller companies due to the associated costs and bureaucratic hurdles. Another problem is the potential for global discrepancies, as the EU's comprehensive regulations may not align with those in non-EU countries, leading to a fragmented global AI regulatory landscape[54]. This could pose challenges for international AI companies and complicate market dynamics

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[50] Whyman, B. (2023, October 10). AI regulation is coming - What is the likely outcome? Center for Strategic & International Studies. Retrieved from https://www.csis.org/blogs/strategic-technologies-blog/ai-regulation-coming-what-likely-outcome

[51] Schwemer, S. F., Tomada, L., & Pasini, T. (2021, June 21). Legal AI systems in the EU's proposed Artificial Intelligence Act. In *Proceedings of the Second International Workshop on AI and Intelligent Assistance for Legal Professionals in the Digital Workplace (LegalAIIA 2021)*, held in conjunction with ICAIL 2021 (pp. 1-8). São Paulo, Brazil.

[52] Wörsdörfer, M. The E.U.'s artificial intelligence act: an ordoliberal assessment. *AI Ethics*(2023). https://doi.org/10.1007/s43681-023-00337-x

[53] Veale, M. & Zuiderveen Borgesius, F. (2021). Demystifying the Draft EU Artificial Intelligence Act — Analysing the good, the bad, and the unclear elements of the proposed approach. *Computer Law Review International*, *22*(4), 97-112. https://doi.org/10.9785/cri-2021-220402

[54] Edwards, L. Lilian. The EU AI Act: A summary of its significance and scope. Newcastle University.

across borders. Furthermore, the dynamic nature of AI technology, which evolves rapidly, poses a significant challenge to the Act's relevance over time[55]. It is crucial yet difficult to keep the regulatory framework updated and aligned with technological advancements, so as new AI applications develop, some aspects of the regulation may quickly become outdated. This necessitates continuous monitoring and adaptive legislative responses to ensure regulations remain effective and pertinent. Therefore, the inability to promptly update these frameworks contributes to why this is considered an ineffective AI policy.

To build trust and facilitate understanding among users, there is a growing call for AI systems to be not only transparent but also explainable[56]. This means that the mechanisms behind AI decisions should be understandable to ordinary users, not just AI experts. Many have proposed that such transparency is essential for critical applications like medical diagnostics or legal adjudication, where understanding AI's decision-making process is crucial for trust and accountability[57]. For instance, in medical diagnostics, a physician might rely on an AI system to suggest treatment options. Here, both the physician and the patient benefit significantly from understanding how the AI arrived at its suggestions, ensuring that the final medical decisions are made with the full knowledge and consent of the involved parties[58]. Similarly, in legal

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[55] Wheeler, T. (2024). The three challenges of AI regulation. Brookings. Retrieved from https://www.brookings.edu/articles/the-three-challenges-of-ai-regulation/

[56] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/

[57] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/

[58] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/

adjudication, where the stakes include fairness and justice, the transparency of AI systems helps prevent biases and errors that could affect lives and livelihoods, thus safeguarding the integrity of legal processes.

The idea beyond the drive for model transparency and explainability in AI faces significant challenges. Firstly, the inherent complexity of AI algorithms, particularly in advanced models like deep learning, makes them naturally opaque and difficult to interpret even for experts[59]. This "black box" nature complicates efforts to make AI processes transparent and understandable to non-experts[60]. Secondly, increasing transparency could potentially expose sensitive algorithmic details, posing security risks or intellectual property concerns[61]. And finally, efforts to simplify explanations of AI decision-making processes might result in oversimplifications that fail to accurately convey the nuances of how decisions are made, leading to misunderstandings or misplaced trust among users[62]. These challenges underscore the need for a balanced policy approach that enhances transparency and explainability without compromising the effectiveness or security of AI systems.

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[59] BUITEN, Miriam C. 2019. "Towards Intelligent Regulation of Artificial Intelligence." *European Journal of Risk Regulation* 10(1): 41–59. doi: 10.1017/err.2019.8.

[60] Pedreschi, D., Giannotti, F., Guidotti, R., Monreale, A., Ruggieri, S., & Turini, F. (2019). Meaningful Explanations of Black Box AI Decision Systems. *Proceedings of the AAAI Conference on Artificial Intelligence*, *33*(01), 9780-9784. https://doi.org/10.1609/aaai.v33i01.33019780

[61] Pedreschi, D., Giannotti, F., Guidotti, R., Monreale, A., Ruggieri, S., & Turini, F. (2019). Meaningful Explanations of Black Box AI Decision Systems. *Proceedings of the AAAI Conference on Artificial Intelligence*, *33*(01), 9780-9784. https://doi.org/10.1609/aaai.v33i01.33019780

[62] Yu, Ronald, and Gabriele Spina Alì. 2019. "What's Inside the Black Box? AI Challenges for Lawyers and Researchers." *Legal Information Management* 19(1): 2–13. doi: 10.1017/S1472669619000021.

While there are numerous proposed ideas for AI regulation that aim to address the complex problems highlighted earlier in my thesis, many of these proposals lack a proven linkage to success. Most regulatory frameworks are still theoretical or in their beginning stages, with little concrete evidence to demonstrate their effectiveness in real-world applications. This gap underscores a critical need for innovative approaches that not only propose theoretical solutions but also provide some type of evidence-based correlation strategies. My thesis introduces a novel perspective on AI regulation, drawing correlations from the successful regulation of historical technologies. By examining historical successes in regulating technologies like railroads and telecommunications, my research highlights specific features of multilateral treaties that are associated with successful regulatory principles and strategies, which can then potentially be adapted to artificial intelligence. Grounded in historical precedents, this analysis lays the groundwork for developing AI regulations that draw upon approaches to achieve similar successful outcomes.

C. Defining Regulation

For the sake of my thesis, I am defining regulation as the establishment of rules, standards, and procedures set by authoritative bodies such as governments, regulatory agencies, or other recognized entities to control, direct, and manage the activities of individuals, organizations, or systems[63]. The purpose of regulation is to uphold the public interest by ensuring

[63] Engler, Alex. The AI regulatory toolbox: How governments can discover algorithmic harms. Brookings. Retrieved from https://www.brookings.edu/articles/the-ai-regulatory-toolbox-how-governments-can-discover-algorithmic-harms/

safety, fairness, efficiency, and compliance with the law[64]. Regulations can apply to a wide range of activities and sectors, including financial markets, healthcare, environmental protection, and consumer goods and services. The process involves monitoring and enforcing compliance with these rules to achieve desired outcomes, such as protecting the environment, ensuring public health and safety, and maintaining fair and competitive markets.

In the technology world, innovation and regulation have always been "complementary forces[65]." Innovation drives "progress and expands the boundaries of what is possible, while regulation ensures that technology is safe and ethical[66]." However, artificial intelligence has brought new challenges to the balance between innovation and regulation. As AI technology advances rapidly, defining regulation in terms of innovative technology and AI becomes increasingly complex and crucial[67]. Regulation in the context of AI and other innovative technologies involves developing rules and frameworks that address the ethical and safety concerns that accompany these advancements. This includes ensuring AI systems operate without bias, respect privacy rights, function reliably and safely in diverse scenarios, and establish fair distribution. The pace at which AI is evolving poses unique challenges for regulators, who must design policies that are flexible enough to adapt to ongoing technological changes without stifling innovation.

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[64] Baldwin, Robert, and Martin Cave, 'Positive Regulation', *Taming the Corporation: How to Regulate for Success* (Oxford, 2020; online edn, Oxford Academic, 17 Dec. 2020), https://doi.org/10.1093/oso/9780198836186.003.0001, accessed 24 Apr. 2024.

[65] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/

[66] Srivastava, D. (2023, April 14). Balancing innovation and regulation: The role of technology policy in the digital age.

[67] Srivastava, D. (2023, April 14). Balancing innovation and regulation: The role of technology policy in the digital age.

To summarize, effective regulation of AI requires an understanding of both the technical aspects and the potential societal impacts of the technology. It calls for regulations that are proactive rather than reactive, anticipating future developments and their implications rather than addressing issues only after they arise[68]. Moreover, the global nature of technology development necessitates international cooperation in AI regulation. Different regulatory standards across countries can lead to a patchwork of rules that complicates global operations for technology companies. Therefore, there is a growing need for harmonized international regulations that balance the promotion of innovation with the protection of public welfare in the AI landscape. This harmonization can help manage risks and maximize the benefits of AI globally, ensuring that technology serves humanity's best interests while keeping ethical considerations at the forefront.

III. Theory and Hypothesis

In this section of the thesis, I explore how certain features and the specific language of multilateral treaties are linked with successful outcomes. I propose a theory that the features written within the treaties that enable certain mechanisms, such as adaptability, transparency, and collaborative coordination, are correlated to successful outcomes. I then examine the impact of these features, particularly their role in minimizing human harm and reducing unfair advantages between nations. This discussion includes a comparative analysis of prior research on case study treaties and associated events. Building on these insights, I formulate a hypothesis and operationalize these findings.

[68] West, D. M., & Allen, J. R. (2018, April 24). How artificial intelligence is transforming the world. Brookings. Retrieved from https://www.brookings.edu/articles/how-artificial-intelligence-is-transforming-the-world/

A. Introduction to Treaty Features and Successful Outcomes

In the realm of international relations, the design and wording of multilateral treaties play a crucial role in linking their effectiveness to successful outcomes. I theorize that the success of multilateral treaties correlates to their specific features, which facilitate effective outcomes through key mechanisms such as adaptability, transparency, and collaborative coordination. These features written into the multilateral treaties not only facilitate clearer understanding and agreement among nations but also ensure that treaties can be dynamically applied to changing circumstances and challenges over time. The strategic incorporation of these features into treaty design is not merely procedural; it can also be linked to the impact of success in achieving the objectives. For instance, I see a linkage that a treaty that effectively incorporates trigger features is more likely to minimize human harm and reduce unfair advantages between nations. Therefore, understanding the importance of these specific features is key to understanding how to craft effective international agreements.

1. Problems with Defining Success

According to some, regulatory success is achieved when a "regulator delivers the right outcomes (for businesses, consumers, and society) by acceptable procedures at the lowest feasible cost[69]." When this occurs, regulation is said to be at its "most positive[70]." However, defining and claiming success through positive regulation "is not free from contest" as the "right

[69] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.
[70] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.

outcomes" and "acceptable procedure" are matters for argument[71]." Breaking it down, I will highlight the two most common complexities involved in defining and assessing success. First, it is not free from contest[72]. This means that such claims of success are not immune to challenges or disputes. In other words, there is room for debate or disagreement about the effectiveness or impact of the regulation. At the heart of regulatory challenges is the clarity of objectives[73]. Regulators must set clear, achievable goals, yet these goals often derive from broadly stated mandates, leading to varied interpretations[74]. For example, Ofcom's mandate to further the interests of citizens and consumers highlights the breadth and potential ambiguity in regulatory objectives, opening them to contestation[75]. The second complexity centers around the 'right' outcomes and 'acceptable procedures.' These phrases refer to the subjective nature of what is considered successful or satisfactory in the context of regulation[76]. "Right outcomes" are the desired effects or results that the regulation aims to achieve, while "acceptable procedures" pertain to the methods or processes used in implementing the regulation, all of which are up for interpretation[77]. What constitutes the "right" outcomes and "acceptable procedures" is not universally agreed upon and can be questioned or debated. Different stakeholders may have varying perspectives on what is effective, appropriate, or beneficial. Success also hinges on the

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[71] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.
[72] Baldwin, R. (2024). *Understanding Regulation*
[73] Baldwin, R. (2024). *Understanding Regulation*
[74] Jennex, Murray E., Stefan Smolnik, and David Croasdell. 2012. "Towards a Consensus Knowledge Management Success Definition." In *Organizational Learning and Knowledge: Concepts, Methodologies, Tools and Applications*, 13. DOI: 10.4018/978-1-60960-783-8.ch201.
[75] Baldwin, R. (2024). *Understanding Regulation*
[76] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.
[77] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.

delivery of substantive outcomes and the operation of procedures that are seen as legitimate and fair by all affected parties[78]. This necessitates regulators being not just effective in their primary tasks but also being perceived as accountable, transparent, and just in their actions[79]. These attributes are fundamental to building and maintaining support, which is critical for regulatory effectiveness[80].

These two problems make it difficult to define and assess success, particularly in the realm of regulatory frameworks. Success in regulation is not merely about achieving intended outcomes; it involves balancing the complications of various interests, managing procedural fairness, and defining what is right. So, to make it simple, I have made the core of regulatory success lie in achieving positive outcomes and avoiding negative ones for the given framework, which will be expanded on in the next section. I have referred to innovative regulatory approaches as it relates to the "Porter Hypothesis." The "Porter Hypothesis" suggests that well-crafted regulation can stimulate beneficial innovations, leading to "win-win situations where both economic and social gains are realized[81]." Such outcomes are contingent upon the ability of regulatory frameworks to promote and harness innovation in ways that balance market

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[78] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.

[79] Jennex, Murray E., Stefan Smolnik, and David Croasdell. 2012. "Towards a Consensus Knowledge Management Success Definition." In *Organizational Learning and Knowledge: Concepts, Methodologies, Tools and Applications*, 13. DOI: 10.4018/978-1-60960-783-8.ch201.

[80] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.

[81] Porter, M. E., & van der Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *The Journal of Economic Perspectives*, *9*(4), 97–118. http://www.jstor.org/stable/2138392

and social objectives efficiently[82]. In terms of the notion of "win-win" outcomes, it is not enough for regulations to aim for social or economic benefits in isolation; they must foster an environment where these benefits can coexist and reinforce each other[83]. Defining and assessing regulatory success is a process that involves more than just the attainment of specific objectives. It encompasses the broader dynamics, and therefore, success is a multidimensional construct that does not have an agreed-upon definition, so it won't be defined as such.

a. Definition of Success in the Context of Multilateral Treaties

In the context of multilateral treaties, the definition of success in my thesis encapsulates two key dimensions:

1. **Avoiding Negative Outcomes**: Successful treaties are linked to effectively preventing or mitigating adverse consequences associated with the issues they address. This includes reducing human harm and ensuring that treaty stipulations do not inadvertently create or exacerbate problems.
2. **Promoting Positive Outcomes**: Beyond avoiding harm, successful treaties are linked to actively contributing to positive changes, such as improving quality of life, enhancing productivity, and fostering fair technological advancement. This aspect is crucial in the contexts where treaties aim to harness technology for societal benefit while managing the risks associated with its deployment.

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[82] Porter, M. E., & van der Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *The Journal of Economic Perspectives*, *9*(4), 97–118. http://www.jstor.org/stable/2138392

[83] Baldwin, Robert, and Martin Cave. 2020. *Positive Regulation and Success*. Pages 15–C2.P57. https://doi.org/10.1093/oso/9780198836186.003.0002.

Building on these foundational dimensions, I then consider how success is measured more specifically in my thesis. The measurement of success I chose in multilateral treaties is linked to specific, tangible outcomes that are grounded in the foundational dimensions of avoiding negative outcomes and promoting positive ones. This detailed measurement approach allows for a complete analysis of how treaties function in real-world scenarios:

1. **Fair Distribution of Gains**: Success is linked in the realm to mean that the benefits derived from adherence to the treaty are distributed fairly among all parties. This does not necessarily imply equal distribution but ensures that no one country disproportionately benefits at the expense of others. This fairness is critical in preventing distribution risks and ensuring that all parties have equitable access to the benefits of cooperation.
2. **Adherence to Rules and Reduction of Cheating**: Linkage to a successful treaty effectively locks in all parties, particularly dominant players who might otherwise exploit their position, to adhere to agreed-upon rules. This includes preventing practices such as technology theft or other forms of cheating that could give some countries an unfair advantage over others.
3. **Mitigation of Existential Risks**: Particularly relevant for treaties involving powerful technologies or significant geopolitical implications, success involves mitigating risks that could potentially threaten human existence or fundamentally disrupt global stability.

The definition of success, therefore, hinges on the treaty's framework containing specific clauses and features that facilitate these outcomes. As referenced above, success is not merely about the creation of the treaty itself but about its ongoing impact and effectiveness in avoiding negative outcomes and creating good ones.

B. Theoretical Framework

International treaties are important in managing global interactions. The effectiveness of these treaties largely depends on their design and the mechanisms they incorporate to address dynamic global challenges. This thesis explores the correlation between specific treaty features and their success, structured around three core hypotheses. This thesis is grounded in the belief that adaptability, collaborative coordination, and transparency are fundamental attributes that come from the features written within the agreements that determine the successfulness. These features have been linked to helping treaties stay relevant and effective amidst changing global circumstances, including technological advancements.

1. Key Features in Treaties Essential for Success

This thesis contends that specific written features in treaties establish mechanisms that are linked with successful outcomes. These features, including amendment provisions, trigger mechanisms, knowledge sharing, and periodic reviews, are hypothesized to create the necessary framework for treaties to remain relevant and successful over time. Each of these features is explored in detail below:

a. **Periodic Reviews:** Periodic reviews are essential for evaluating a treaty's effectiveness and making necessary adjustments to its terms. These reviews should be mandated at regular intervals (e.g., every 2-5 years) as written provisions within the treaty. This feature allows signatories to discuss and refine treaty terms based on the latest data, experiences, and technological advancements, ensuring the treaty evolves in line with the current global context and continues to meet its objectives effectively.

b. **Amendment Provisions:** Amendment provisions are critical features as they allow for the treaty to be updated without the need to renegotiate the entire agreement. These provisions should be clear and practicable, enabling modifications that reflect evolving circumstances and consensus among parties. Effective amendment mechanisms are found to ensure that treaties can respond swiftly to global changes, such as changes in political dynamics, economic crises, or technological advancements.

c. **Trigger Mechanisms:** Trigger mechanisms are predefined responses within treaties that activate under specific conditions, ensuring that treaties are proactive rather than reactive. These mechanisms can be based on technological thresholds, environmental benchmarks, or political events, providing a structured and predictable method for adapting treaty terms dynamically. Trigger mechanisms help maintain the treaty's relevance and effectiveness, allowing it to function as a living document that responds appropriately to new challenges.

d. **Knowledge Sharing:** Knowledge sharing is a fundamental feature that can be correlated to the success of treaties, particularly in fields requiring a high level of technical and scientific understanding. By incorporating obligations for the exchange of scientific, technical, environmental, and legal information, treaties can democratize access to crucial advancements and innovations. This prevents wealthier or more technologically advanced nations from dominating benefits, promoting a more balanced distribution of resources. Provisions for shared databases and collaborative platforms further support this by ensuring that all parties, regardless of their economic or technological status, have opportunities to access and utilize this information. Such measures reduce the risk of

knowledge monopolies and help level the playing field by facilitating transparency and trust among signatory states.

Integrating features such as amendment provisions, trigger mechanisms, knowledge sharing, and periodic reviews into international multilateral treaties fosters key mechanisms like adaptability, transparency, and collaborative coordination. These features ensure that treaties are not only responsive to changes but also maintain open lines of communication and foster cooperation among signatories. Adaptability is achieved through flexible legal frameworks and responsive implementation mechanisms, allowing treaties to evolve in response to new circumstances without requiring full renegotiations. Transparency and collaborative coordination are enhanced by the systematic sharing of information, which builds trust and ensures all parties are informed and accountable. Together, these mechanisms link directly to successful outcomes by creating a more responsive, equitable, and cohesive international treaty system that can effectively manage and mitigate the challenges of innovative technology.

C. Hypothesis

In this section, I propose and explore three hypotheses centered on the features that potentially link to the success of multilateral treaties. Each hypothesis focuses on a different aspect of treaty design—hypothesizing that these specific features correlate to achieving desired outcomes.

Hypothesis 1: Treaties that require periodic review conferences every 2-5 years, which mandate regular evaluations and adjustments in response to evolving circumstances; amendment mechanisms that allow for modifications to address new challenges and ensure relevance; and

provisions for responding to technological advancements to keep the treaty current are linked to success.

Hypothesis 2: Treaties or agreements that obligate comprehensive knowledge sharing—specifically, the exchange of scientific, technical, environmental, and legal information within shared databases and collaborative platforms—are linked to success.

Hypothesis 3: Treaties and agreements that include trigger mechanisms, which are activated to adjust in response to specific events or criteria, are linked to success

Therefore, my hypotheses are based on changes in treaty dynamics rather than static treaty conditions. These dynamic factors are linked to ensuring that treaties remain effective and relevant. I posit that key mechanisms such as adaptability, transparency, and Collaborative Coordination are indicative of success, prompted by these features, and would not be observed during periods of rigidity where treaties lack such mechanisms. However, there are potential limitations and challenges in empirically validating these hypotheses, such as the complexity of isolating specific treaty features that directly contribute to perceived successes or failures. If supported by the data, these hypotheses would demonstrate a degree of robustness in treaty design that correlates with successful outcomes. Additionally, the data would support a theory of "dynamic compliance," where treaties that have periodic review conferences, amendment provisions, knowledge sharing, and trigger mechanisms tend to achieve their goals more effectively. As instances of treaties with these characteristics are analyzed, I aim to link these features to the success of innovative technology treaties but acknowledge that the specific impacts and effectiveness can vary depending on the domain of the technologies involved. While

the foundational principles of adaptability, transparency, and Collaborative Coordination are hypothesized to correlate with the success of multilateral treaties, the nuances of how these features are implemented may differ. Each sector—other than innovative technology like healthcare or environmental protection—presents unique challenges and requirements that might necessitate modifications to these general principles to tailor them effectively to the specific context.

IV. Methodology

In the following section, I outline my case study method approach to investigating the proposed hypotheses. To do so, I use 4 case studies collected that represent the same kind and same degree as artificial intelligence. These chosen historical innovative technologies have been subject to regulatory frameworks, and I incorporate analysis to provide a deeper understanding of regulatory impacts across different fields. This comprehensive methodology, across technological domains and regulatory environments, provides a broad and nuanced dataset for evaluating the success of these regulations.

A. Case Study

In this thesis, a critical component of my research methodology involves the detailed study of various multilateral international treaties to identify and analyze the specific written features that contribute to their success. This analysis focuses on extracting and examining the precise wording and features used in treaties that support key mechanisms such as adaptability, transparency, and collaborative coordination. To conduct this analysis, I systematically review all

the selections of treaties and dissect the language and clauses of these documents with the aim of understanding how specific terms and formulations correlate with successful treaty outcomes. This involves a close examination of how amendment provisions are articulated, the specific triggers detailed in trigger mechanisms, the clauses that facilitate knowledge sharing, and the stipulations that mandate periodic reviews. The process includes comparing the language across different treaties to identify commonalities and variations in their approach to these crucial features. Additionally, I assess how the wording and features influence the practical implementation and effectiveness of the treaty provisions. This analysis not only highlights which features are most effective but also provides insights into how the language can be optimized in future treaties to enhance their functionality and success. Through this meticulous examination of treaty wording, this research contributes to a deeper understanding of how textual elements within treaties can be strategically used to foster environments conducive to adaptability, transparency, and collaborative coordination, ultimately leading to more successful outcomes in international agreements. This can then be used as insight for policymakers to structure international agreements on future innovative technologies.

In the methodology for analyzing the impact of treaty features on railroad regulation success, this thesis employs a statistical approach to gather and interpret data. Utilizing the Federal database along with archives from Great Britain, statistics on railroad accidents over a period of two decades were meticulously collected. This data provides a foundational understanding of the frequency and severity of incidents before and after the implementation of specific treaty features. To synthesize these findings, I conducted a detailed analysis over a span of 10-15 years, calculating the average number of incidents per year and then comparing these

figures to the same metrics from the 10-15 years prior to the treaty's implementation. This statistical averaging offers a clear, longitudinal view of trends, allowing for an assessment of the effectiveness of treaty provisions in reducing human harm and enhancing safety in railroad operations. This approach not only quantifies the tangible benefits of treaty features but also reinforces the correlation between written treaty elements and measurable improvements in safety outcomes.

1. International Treaties

The decision to focus on international treaties rather than domestic policies stems from several considerations related to the scope, impact, and nature of innovative technologies. This choice is rooted in the understanding that many technological advancements—particularly those with far-reaching consequences and applications—transcend national boundaries, requiring a coordinated global approach for effective regulation and management. Innovative technologies such as artificial intelligence, biotechnology, and cybersecurity have implications that affect multiple countries or even the entire globe. Issues such as data privacy, cyber security threats, and the ethical deployment of AI systems cannot be effectively managed through domestic policies alone due to their inherent international characteristics. International treaties provide a framework for the collective action needed to address these complex, cross-border challenges. Furthermore, international treaties help in harmonizing standards across countries, which is crucial for technologies that operate on a global scale. For instance, consistent regulations are necessary to manage the internet, global telecommunications, and the movement of digital information. By focusing on international treaties, this thesis aims to understand how global norms and standards are negotiated and implemented, ensuring that technologies work smoothly

and safely across different regulatory environments. Additionally, I look to see how addressing global challenges related to innovative technologies requires cooperation and coordination among nations and how International treaties facilitate this by bringing together diverse nations to negotiate and agree upon common goals and strategies. This collaborative approach is essential for tackling issues that no single nation can solve independently.

I argue that International treaties often set precedents that influence domestic policies. By establishing minimum standards and norms, these treaties can shape national legislation, pushing countries towards higher standards of regulation and enforcement[84]. Analyzing international treaties allows for an understanding of how global consensus and international law can drive domestic policy changes, especially in areas where national policies may be lacking or inconsistent. My study of international treaties in relation to innovative technologies allows for a more comprehensive analysis of how these agreements impact technological advancement. This perspective is crucial for evaluating the success of international legal agreements.

2. Multilateral Treaties

I have opted to focus on multilateral treaties over bilateral treaties due to several key considerations specific to innovative technologies. This decision is informed by the fundamental differences in scope, objectives, and impacts between multilateral and bilateral treaties, particularly in relation to global public goods and the broad-ranging implications of technological advancements.

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[84] Simmons, Beth A., and Daniel J. Hopkins. 2005. *The Constraining Power of International Treaties: Theory and Methods*. Cambridge University Press. Published online October 31, 2005.

Multilateral treaties involve multiple countries and are designed to address issues that transcend national borders, making them particularly suited for tackling global challenges such as technological regulation. These treaties often aim to create or support global public goods that benefit humankind as a whole rather than serving the interests of any individual nation[85]. The nature of innovative technologies often positions them as global public goods, where the benefits and risks associated with these technologies can impact a wide range of actors across national boundaries. Multilateral treaties are particularly effective in governing such technologies because they aim to maximize collective benefits and minimize harms on a global scale. In contrast, bilateral treaties typically involve only two countries and are often crafted to address specific bilateral interests or issues. In addition, the scope of bilateral treaties is usually narrower, focusing on the specific interests of the parties involved rather than broader global concerns. Innovative technologies often have implications that reach beyond the bilateral context, affecting multiple nations and even the global community. Issues such as cybersecurity, data privacy, and the ethical use of artificial intelligence require coordinated efforts among many countries to manage risks and harness benefits effectively. Multilateral treaties are better suited to handle these complexities because they provide a framework for collective action and cooperation among nations.

The logic of using multilateral treaties for innovative technologies lies in their ability to facilitate comprehensive agreements that are capable of addressing the wide-reaching effects of these technologies. Given the global implications of innovative technologies, this thesis focuses on multilateral treaties as they are more relevant for studying how international law can regulate

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[85] Venne, Sharon H. "Treaties Made in Good Faith."

technologies that impact multiple jurisdictions and populations. This focus allows for a broader examination of how international mechanisms contribute to the regulation of technologies as global public goods. Furthermore, the multilateral approach aligns with the goals of creating effective solutions that address not only the interests of individual nations but also the collective interests of the global community.

In the context of my thesis, the selection of specific multilateral treaties—namely, the Convention Concerning International Carriage by Rail (CIV), Convention concerning International Carriage by Rail of Goods (CIM), the International Telegraphy Treaty (ITY), the Energy Charter Treaty, the Treaty on the Prohibition of Nuclear Weapons and the Treaty on the Non-Proliferation of Nuclear Weapons—were chosen due to their significant implications for global technological governance. These treaties have wide acceptance and ratification by numerous countries, which signifies a strong global consensus and commitment to managing the interdependencies of modern technological infrastructures and addressing complex global challenges. The CIV and CIM treaties, focusing on rail transport, represent one of the earliest forms of international technology regulation. They are significant international multilateral treaties that enhance the efficiency and reliability of cross-border rail transport. The 1865 International Telegraph Conference represents one of the earliest forms of telecommunication regulation. This landmark event marked a significant turning point in how communications were managed across borders, setting the stage for the systematic regulation of international telegraphy[86]. The Energy Charter Treaty addresses the complexities of energy production and trade in the globalized world, which is increasingly influenced by technological advancements in

[86] International Telecommunication Union. 2024. Members Directory - ITU Hub. Accessed April 1, 2024.

energy efficiency and renewable technologies. Lastly, the Treaty on the Prohibition of Nuclear Weapons and the Treaty on the Non-Proliferation of Nuclear Weapons are critical in the context of security technologies. These treaties not only regulate a specific category of high-risk, innovative technologies but also establish norms and expectations for international behavior, demonstrating how multilateral frameworks can influence global security dynamics and technological development. Together, these treaties provide a comprehensive view of how multilateral agreements facilitate the management and regulation of technologies across different domains. They highlight the necessity of international cooperation for effective technology governance and highlight the importance of multilateral international treaties in setting global standards and fostering international consensus on emerging technological challenges. This aligns with the goals of considering the collective interests of the global community, making it an exemplary method for studying the implications of innovative technologies through the lens of international law.

To start out in selecting case studies for this thesis, I made a deliberate choice to include both historical and contemporary technologies to provide a comprehensive view of how international treaties have evolved in response to technological advancements over time. This approach allows for a deeper understanding of the underlying features and mechanisms that govern international technology regulation, highlighting both continuities and shifts in regulatory approaches and priorities. The case studies were carefully selected based on their historical and contemporary relevance, their transformative impact on society, and their illustration of critical regulatory challenges and successes. In selecting the case studies for this thesis, I have chosen to focus on multilateral treaties concerning four critical areas of technological innovation:

Railroads, telegraphs, electricity, and nuclear weapons. Each of these technologies represents a significant leap and is related to artificial intelligence by the same kind or the same degree. I view their regulation through international treaties as providing a solid framework for analysis.

The inclusion of historical technologies such as railroads and telegraphs offers valuable insights into the initial challenges and solutions found in the international regulation of technology. By examining these cases, we can trace the origins of certain regulatory frameworks and understand how foundational decisions shaped subsequent developments in technology governance. These historical examples also show how treaties can adapt over time to new challenges and technologies, providing correlations on flexibility, transparency, and collaborative coordination between national interests. Conversely, the inclusion of more recent technological advancements like nuclear weapons and electricity allows the thesis to address modern regulatory challenges that are highly relevant today. These technologies, which involve significant ethical, environmental, and security considerations, require sophisticated and nuanced regulatory approaches. Studying these cases helps identify how contemporary treaties have adapted to manage complex risks and distribute benefits in an equitable manner. It also sheds light on the negotiation processes that underpin modern treaties, including the role of scientific knowledge, international diplomacy, and global governance structures.

By analyzing both historical and newer technologies, this thesis bridges past and present, offering a unique perspective on the trajectory of technology regulation. This dual approach enables an assessment of how well historical regulatory frameworks have adapted to contemporary challenges and provides a framework for predicting how current technologies might be managed on the international stage in the future. Additionally, this approach facilitates

a dynamic understanding of how regulatory principles and practices have evolved, responding to changes in technology, political landscapes, and global priorities. Ultimately, the combination of historical and contemporary case studies enriches the analysis, providing a more robust and nuanced understanding of the factors that lead to successful international technology regulation. This methodology not only highlights effective strategies and common pitfalls but also underscores the importance of learning from the past while actively shaping future regulatory frameworks to address ongoing and emerging global challenges.

I selected railroads and telegraphs as case studies because they exemplify technologies of the "same kind" that fundamentally transformed communication and transport during their respective periods. These innovations played pivotal roles in shrinking geographical distances and enhancing connectivity, much like the role of the Internet and mobile communications today. The development of railroads and telegraphs led to significant economic and social changes, driving mass industrialization and urbanization[87]. Multilateral treaties governing these technologies, such as those facilitating cross-border rail networks and international telegraph agreements, set important precedents for how infrastructure that crosses national boundaries can be managed collectively. They provide valuable insights into the coordination and regulatory challenges that similar contemporary technologies face, particularly in ensuring equitable access and preventing monopolistic practices.

I chose to use electricity as a case study because it exemplifies a transformative technology that is categorized under the "same kind" as artificial intelligence. Electricity's role in

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[87] International Telecommunication Union. "Members Directory - ITU Hub." Accessed April 2, 2024.

fostering economic development and improving quality of life aligns closely with my thesis's focus on how international treaties can harness technology for societal benefit while managing associated risks. Moreover, electricity, as a critical infrastructure, requires international cooperation to ensure its reliable and equitable distribution, making it an ideal subject for studying the success of multilateral treaties. This choice also provides a contemporary parallel to historical innovations, allowing me to explore both the continuity and evolution of international regulatory frameworks over time. Through the lens of electricity, my analysis seeks to understand how treaties can effectively manage such essential technologies, balancing innovation with safety, sustainability, and equitable access.

I chose the case study of Nuclear weapons and categorized it under “same degree” as innovative technology due to their profound impact and the high stakes involved in their regulation. Nuclear technology not only encompasses advanced science but also significant geopolitical and ethical considerations. Treaties related to nuclear arms control, such as the Non-Proliferation Treaty (NPT), demonstrate how international agreements manage technologies with a high degree of impact on national security and global stability. These treaties are pivotal in understanding how international law tackles technologies that pose existential risks—paralleling contemporary concerns about technologies like AI and cyber warfare, which also have the potential to drastically alter human existence.

These cases were chosen because they all exhibit risks related to unfair distribution and the potential for existential harm. For example, nuclear weapons carry risks that could potentially end human existence or fundamentally alter it. Similarly, railroads, telegraphs, and electricity, on a smaller scale, possess the potential for significant harm through the disruption of critical

infrastructure, economic instability, and environmental damage, which could cumulatively threaten societal structures and human welfare. In addition, railroads and telegraphs drastically changed job markets and social structures during their time, showing how technology can redistribute power and resources, sometimes leading to inequalities. These studies are crucial for understanding how to design treaties that not only mitigate such risks but also ensure that the gains from technological advancements are distributed fairly—not equally but in a manner that compensates for disparities and prevents any single entity from monopolizing benefits at the expense of others. By analyzing these technologies and their corresponding treaties, this thesis aims to draw lessons that correlate on how best to regulate current and future technologies to promote global public goods, prevent harm, and ensure fair and just benefits for all involved.

In addition to the 4 case studies I chose to analyze in my thesis, there were two other innovative technologies - the Printing Press and Biotechnology that I was interested in utilizing but ultimately decided not to for reasons relating to their framework. The existing international treaties related to biotechnology each focus on specific aspects of the field rather than encompassing it as a whole. This segmentation did not allow me to gather a comprehensive understanding of how innovative technology features a mechanism for success. Treaties like the Cartagena Protocol on Biosafety primarily address environmental and safety concerns related to the transfer, handling, and use of genetically modified organisms. In contrast, aspects related to bioweapons are handled under treaties such as the Biological Weapons Convention (BWC). There isn't a single treaty that covers all aspects of biotechnology comprehensively, from GMOs to biopharmaceuticals and bioweapons. The lack of a comprehensive treaty means that studying biotechnology in the context of international law would require dealing with multiple specific

agreements, each with its own set of regulations, guidelines, and enforcement mechanisms. This can make the research scope too broad and unwieldy, particularly for a thesis aiming to focus on the mechanisms for success in innovative technologies. Therefore, I chose to exclude biotechnology to maintain a manageable and focused scope.

Similarly, I decided not to choose the printing press for a case study because it does not align with one of the key criteria I set for the study: the existence of a multilateral international treaty related to the technology. The printing press, despite its significant historical impact on information dissemination and literacy, does not have any multilateral international treaties governing its use or propagation. The printing press, first developed by Johannes Gutenberg in the mid-15th century, fundamentally transformed the dissemination of information but did so with a distinctly regional focus during its early years[88]. Initially, the technology spread throughout Europe at a pace and manner heavily influenced by geographical, political, and cultural factors unique to each area[89]. In regions with established scholarly communities and commercial centers, such as major cities in Germany, Italy, and later France and England, the press quickly became a critical tool for spreading both religious and secular knowledge[90]. Each region adapted the technology to suit its local needs, which often led to variations in the types of printed materials. For example, in Italy, there was a strong emphasis on printing classical Latin texts to support the humanist movements, whereas, in Germany, the press was crucial for

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[88] Eisenstein, Elizabeth L. *The Printing Press as an Agent of Change*. Cambridge University Press.
[89] Eisenstein, Elizabeth L. *The Printing Press as an Agent of Change*. Cambridge University Press.
[90] Dittmar, Jeremiah E. 2011. "Information Technology and Economic Change: The Impact of The Printing Press." *The Quarterly Journal of Economics* 126 (3): 1133-1172. https://doi.org/10.1093/qje/qjr035.

spreading Martin Luther's writings during the Protestant Reformation. These regional adaptations show how the technology was not just a means of mass communication but also a reflection of regional priorities and cultural values. Moreover, the absence of a unified international regulatory framework allowed the printing press to evolve differently across regions. Each area developed its own standards and practices concerning printing, leading to diverse typographical styles and approaches to publishing. The spread of the printing press was thus a series of localized explosions of technology and culture rather than a uniform global movement. This regional focus has implications for understanding the technology's adoption and the varying rates at which print culture developed across Europe. This absence of a multilateral treaty makes it less suitable for my analysis, which focuses on how such treaties can influence the success of innovative technologies globally.

a. Advantages

The methodology employed in this thesis is case studies, which offer significant advantages particularly suited to the exploration of complex subjects like the regulation of innovative technologies through international multilateral treaties. Case studies are exceptionally effective for delving into specific historical details and tracing the causal processes that are often obscured in broader quantitative analyses. This method allows for an in-depth examination of how particular decisions, policies, and treaty features have evolved and influenced outcomes over time. Process tracing, a key component of the case study methodology, facilitates a detailed exploration of the correlation between variables by uncovering the mechanisms through which certain effects occur. For instance, while statistical methods might establish that certain treaty features are associated with successful outcomes, they do not reveal how these features

contribute to success. Case studies enable the construction of a causal chain that explains the sequence of events or decisions leading from specific treaty provisions to their impacts. In the context of this thesis, such an approach is invaluable for demonstrating, for example, how adaptability in treaties leads to sustained effectiveness or how collaborative coordination enhances compliance and implementation. By focusing on the detailed pathways of influence and interaction, case studies provide a richer and more comprehensive understanding of complex phenomena.

b. Limitations

The case study methodology also presents certain limitations, primarily related to the scope and generalizability of the findings. One of the main limitations is the relatively small number of data points that can be realistically analyzed in-depth within the scope of a thesis. Unlike methodologies that collect large datasets to produce findings that are statistically significant across broad populations or a large number of instances, case studies typically focus on a much smaller number of examples. This limitation can pose challenges in terms of the generalizability of the results.

In the specific context of this thesis, the focus on a limited number of case studies—railroads, telegraph, nuclear weapons, and electricity—means that the findings may not be directly applicable to all forms of innovative technologies or all types of international treaties. Additionally, while case studies can provide profound insights into the cases selected, they may overlook broader trends or exceptions beyond the chosen examples. The intensive nature of case study research also means that the conclusions drawn may be influenced by the unique

characteristics of the few selected cases, which might not represent the broader category of similar phenomena, especially in a field as diverse as international treaty regulation of innovative technologies.

Furthermore, by examining only cases that show positive outcomes, the scope of my conclusions is inherently constrained. This selection bias limits my ability to definitively state what might occur in situations where treaties fail, as the analysis does not encompass the full spectrum of potential outcomes. Consequently, it is challenging to find case studies of innovative technology treaties that are clear failures, as such treaties are often not as well-documented or extensively analyzed in academic and policy-making circles. Typically, less successful initiatives may be quietly revised, abandoned, or merged into broader frameworks without significant public discourse or detailed post-mortem analysis, which can obscure their visibility and accessibility for academic research.

The methodology employed leans more towards inductive rather than deductive reasoning, focusing on analyzing existing examples to draw broader lessons about what contributes to success in the context of multilateral treaties. While this approach allows for detailed insights into the characteristics of successful treaties, it also means that the conclusions are primarily based on observation and correlation, not on a predetermined theoretical framework tested against varied instances. Consequently, this makes my findings more correlational than causal, highlighting associations between specific treaty features and successful outcomes without definitively proving causation. In light of these considerations, the language used to present the findings is intentionally measured and cautious. It emphasizes that while certain features appear to be linked with successful outcomes, these relationships are not

definitively causal. Therefore, while the identified features can be associated with success, they should not be interpreted as guaranteeing it.

V. Case Studies

This section of the thesis examines the effectiveness of multilateral treaties through a detailed analysis and is guided by three hypotheses stated in my Theory and Hypothesis section. To reiterate, I am measuring the linkage of case studies based on the success as defined by the treaties' ability to reduce existential risks, ensure fair distribution of technology and economic gains, and prevent cheating and monopolistic practices.

A. Railroad Case Study

The development of railroads has been a pivotal force in shaping economies and societies across the world. Starting with the Industrial Revolution in Britain during the early 19th century, rail transport quickly became fundamental to industrialization efforts in various countries, promoting unprecedented economic growth and facilitating the expansion of territories[91]. Europe was the birthplace of railroads, with the United Kingdom developing this technology[92]. As railroads spread across the continent, different countries adopted and adapted railway technology to suit their geographic and economic contexts.

The expansion of railroads in the 19th and early 20th centuries was a transformative development that reshaped nations and continents. As the railroad networks of different countries began to intertwine, the rail systems frequently crossed national boundaries, fundamentally

[91] Kolko, Gabriel. *Railroads and Regulations, 1877-1916*. Princeton University Press.
[92] Kolko, Gabriel. *Railroads and Regulations, 1877-1916*. Princeton University Press.

enhancing the potential for international trade and travel[93]. This integration, while beneficial, brought with it a unique set of challenges and complexities, highlighting the need for cohesive international regulation. As these individual national networks grew, they often did so in isolation, following domestic needs and specifications without consideration for neighboring systems[94]. As a result, when these rail lines began to meet at national borders, the lack of synchronization became a significant impediment. Disparities in rail gauges, operational protocols, and safety standards meant that what should have been a smooth transition from one country's system to another often involved cumbersome and time-consuming processes[95]. The direct impact of these inconsistencies was most clearly observed in trade and logistics[96]. Trains carrying goods across borders sometimes had to unload their cargo and transfer it to different trains built to different specifications. Passengers traveling internationally faced similar disruptions, with prolonged border stops for train changes or gauge adjustments[97]. Such inefficiencies not only hindered economic activity but also discouraged cross-border travel and commerce. It became increasingly clear that uniform protocols across various operational and technical aspects—such as track gauges, signaling systems, and train controls—were essential to optimize the benefits of international rail connectivity.

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[93] Herrera, Geoffrey L. 2012. *Technology and International Transformation: The Railroad, the Atom Bomb, and the Politics of Technological Change*. Albany: State University of New York Press.
[94] Herrera, Geoffrey L. 2012. *Technology and International Transformation: The Railroad, the Atom Bomb, and the Politics of Technological Change*. Albany: State University of New York Press.
[95] Association of American Railroads. "Chronology of America's Freight Railroads."
[96] Association of American Railroads. "Chronology of America's Freight Railroads."
[97] Herrera, Geoffrey L. 2012. *Technology and International Transformation: The Railroad, the Atom Bomb, and the Politics of Technological Change*. Albany: State University of New York Press.

Before the implementation of regulations, the rapid expansion of railroads brought about significant issues and challenges. Safety concerns were prevalent in the early years of rail travel, with frequent derailments, collisions, and accidents often due to poor track maintenance, inadequate safety standards, and lack of communication technologies[98]. The absence of standardized safety protocols exacerbated these risks. Monopolistic practices were also particularly notable in regions like North America and Europe, where a few large companies came to control substantial portions of the rail industry[99]. These monopolies could manipulate prices and services, stifling competition and exploiting consumers and smaller towns, which either had to accept high rates or remain disconnected. Additionally, corruption and speculation further complicated the industry. The financing and construction of railroads were often marred by corruption, as evidenced by the Crédit Mobilier scandal of the 1870s in the U.S., which exposed high-level corruption in railroad construction contracts, highlighting the extent of financial mismanagement and fraud[100]. Finally, economic displacement also arose as an issue; while railroads were a boon for many larger cities and towns, they could also lead to economic displacement[101]. Communities bypassed by new rail lines often found themselves economically isolated, leading to declines and disparities that were not addressed until much later[102].

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[98] Shi, Feli X., Siew Hoon Lim, and Junwook Chi. 2010. "Title of the Article." *International Journal of Productivity and Performance Management*. Published on 26 April 2010. ISSN: 1741-0401.

[99] Shi, Feli X., Siew Hoon Lim, and Junwook Chi. 2010. "Title of the Article." *International Journal of Productivity and Performance Management*. Published on 26 April 2010. ISSN: 1741-0401.

[100] Kens, Paul. 2009. "The Crédit Mobilier Scandal and the Supreme Court: Corporate Power, Corporate Person, and Government Control in the Mid-nineteenth Century." First published on 15 June 2009. DOI: 10.1111/j.1540-5818.2009.01207.x.

[101] Hay, William W. *Railroad Engineering*. John Wiley & Sons.

[102] Hay, William W. *Railroad Engineering*. John Wiley & Sons.

To further this, the challenges were not limited to technical and operational issues; they extended into regulatory domains. Different countries had their own sets of rules governing railway operations, safety standards, and worker protocols[103]. This regulatory patchwork created a complex landscape for international rail operators, who had to navigate varying standards and compliance requirements[104]. The economic implications of these discrepancies were also profound. Markets that could have been seamlessly connected through efficient rail links remained fragmented, affecting the economic growth potential of regions and the global economy[105]. As global markets became more integrated, it was vital to enhance the competitiveness of international rail transport relative to other modes like maritime and air transport. Improving the efficiency and reliability of rail services was crucial for maintaining their economic viability in a rapidly globalizing economy. Furthermore, the strategic implications of rail connectivity—such as military mobility and crisis response—emphasized the need for an internationally cohesive rail system[106]. During times of conflict or emergency, the ability to move resources and personnel swiftly across borders was critically hampered by the lack of standardized rail systems[107]. Given all these problems, the solution laid in international cooperation to develop a treaty that would standardize rail operations across borders, thereby

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[103] Waters II, William G. 2007. "Evolution of Railroad Economics.
[104] Waters II, William G. 2007. "Evolution of Railroad Economics.
[105] Waters II, William G. 2007. "Evolution of Railroad Economics.
[106] Shi, Feli X., Siew Hoon Lim, and Junwook Chi. 2010. "Title of the Article." *International Journal of Productivity and Performance Management*. Published on 26 April 2010. ISSN: 1741-0401.
[107] Kens, Paul. 2009. "The Crédit Mobilier Scandal and the Supreme Court: Corporate Power, Corporate Person, and Government Control in the Mid-nineteenth Century." First published on 15 June 2009. DOI: 10.1111/j.1540-5818.2009.01207.x.

simplifying logistics, enhancing safety, and promoting a more integrated approach to rail transport.

In comparing railroads to artificial intelligence and other innovative technologies, their classification under the "same kind" highlights not only their transformative impact but also the broader implications they have on societal structures and individual lives. Both railroads and AI have significantly disrupted existing norms and systems, paving the way for new economic and social landscapes. This disruption, while fostering growth and innovation, also presents challenges that need careful management through international treaties and regulations.

Both railroads and AI, as transformative technologies, carry the potential for human harm if not regulated appropriately. For railroads, this involved safety issues and labor exploitation during their rapid expansion in the 19th century[108]. In the case of AI, concerns revolve around privacy, surveillance, and the potential for autonomous systems to make life-or-death decisions without human oversight[109]. These technologies pose existential risks in different contexts, as discussed in earlier sections. Effective regulation is crucial to mitigate these risks, ensuring that technological advancement does not compromise human safety.

In addition, both railroads and AI illustrate the problem of unfair distribution of gains—a critical issue in economic and social equity. Railroads often led to significant disparities in economic development, concentrating wealth in certain regions or among certain groups while

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[108] Schivelbusch, W. (1978). Railroad Space and Railroad Time. *New German Critique*, *14*, 31–40. https://doi.org/10.2307/488059

[109] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee.

marginalizing others[110]. Similarly, AI has the potential to create significant economic divides, particularly through job displacement and the consolidation of technological power in the hands of a few corporations[111]. This concentration of benefits risks exacerbating social inequalities, making it imperative for international treaties to incorporate measures that ensure a fairer distribution of technological gains.

The Berne Railroad Convention marked one of the first major successful international cooperation attempts to standardize and regulate a complex, cross-border technological system—railways. I chose to concentrate on the outcomes of the Berne Convention, which encompassed two agreements: the "Carriage of Passengers and Goods by Rail," abbreviated as CIV, and the "Carriage of Goods by Rail," abbreviated as CIM. These agreements are important due to their historical significance and role in standardizing and facilitating cross-border rail traffic, which helped overcome significant logistical and technical barriers that previously hindered international railway operations[112]. The CIV was originally part of the broader International Convention concerning the Carriage of Goods by Rail (CIM) and later integrated into COTIF[113]. This agreement deals specifically with passenger services and their luggage while the the CIM focuses on the regulations related to the international transport of goods by rail, including provisions on the documentation required, carrier liability, claims procedures, and

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[110] Schivelbusch, W. (1978). Railroad Space and Railroad Time. *New German Critique*, *14*, 31–40. https://doi.org/10.2307/488059

[111] Matthews, J. (n.d.). Practical strategies for regulation and risk management from the IEEE 1012 standard for system, software, and hardware verification and validation. IEEE-USA AI Policy Committee.

[112] Beniger, James. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge: Harvard University Press, 1986.

[113] Beniger, James. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge: Harvard University Press, 1986.

other legal obligations[114]. Both of these conventions significantly changed international transport laws and regulations. Their impact highlights the significance of structured legal frameworks, making them excellent multilateral treaties to study for the effectiveness of this thesis.

The issues tackled at the Berne Convention mirror many of the challenges faced by modern international treaties aimed at regulating innovative technologies. Just as the convention sought to harmonize differing national standards to create a cohesive railway system, modern treaties must address similar disparities in standards and regulations when dealing with technologies like artificial intelligence. The framing of the multilateral agreements that came from the Berne Convention serves as an exemplary framework for how countries with varying interests and priorities can come together to agree on common standards and practices. This aspect is especially pertinent to the thesis, illustrating that well-negotiated treaties can lead to compromises acceptable and beneficial to all parties, even when they have conflicting interests, as was evident with the rail systems in Europe. The CIV and CIM effectively addressed these challenges through the harmonization of different national laws and technical standards across Europe, which had been a considerable obstacle to the efficient and safe movement of goods and passengers. By resolving these differences and creating a unified railway system, the convention set a precedent for how countries could collaborate on common standards and protocols for mutual benefit. This is particularly relevant to the study of modern technologies like artificial intelligence, where international standards and cooperation are crucial for managing cross-border implications and ensuring broad-based benefits. They also provide valuable insights into how

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[114] Beniger, James. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge: Harvard University Press, 1986.

international treaties can mitigate human harm and address the unfair distribution of gains—two critical issues that I am exploring.

a. The Timeline of Regulation of Railroads

Mid-19th Century: Initial discussions about international railway cooperation began, mainly in Europe, as countries recognized the need for standardized railway systems to facilitate cross-border travel and goods transport[115].

1878: The first International Railway Congress was held in Brussels. This was a forum for discussing technical, administrative, and economic issues related to international rail transport.

1882: The International Union of Railways (UIC) was established to standardize and regulate international railway operations. This organization played a key role in harmonizing technical standards, such as gauge sizes, signaling systems, and ticketing agreements[116].

1886: The Convention concerning the Carriage of Goods by Rail (CIM) was signed in Bern, Switzerland. This was one of the first treaties to regulate the international carriage of goods by rail, aiming to establish a uniform set of rules across national borders[117].

1890: The International Convention concerning the Carriage of Passengers and Luggage by Rail (CIV) was also signed in Bern. Similar to the CIM, this convention aimed to standardize regulations governing the international transport of passengers and their luggage[118].

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[115] U.S. Department of Transportation, Bureau of Transportation Statistics. "National Transportation Statistics." Washington, DC: U.S. Government Printing Office, 2001.
[116] Kolko, Gabriel. *Railroads and Regulations, 1877-1916*. Princeton: Princeton University Press.
[117] U.S. Department of Transportation, Bureau of Transportation Statistics. "National Transportation Statistics." Washington, DC: U.S. Government Printing Office, 2001.
[118] Kolko, Gabriel. *Railroads and Regulations, 1877-1916*. Princeton: Princeton University Press.

1923: The International Regulations concerning the Carriage of Dangerous Goods by Rail were adopted. This set standards for transporting hazardous materials across international lines safely.

1970: The Convention on the Contract for the International Carriage of Goods by Rail (CIM) was revised and updated in the CIM 1970 Protocol to modernize the provisions and adapt to new logistical challenges and technologies[119].

1980: The International Rail Transport Committee (CIT) published the first uniform rules concerning the contract of international railway passenger transport (CIV) and luggage.

1985: Adoption of the Convention on International Transport by Rail (COTIF), which aimed to unify all private law concerning international rail traffic, simplifying the legal framework for cross-border rail transport in Europe[120].

1999: The COTIF convention was modified to adapt to changes in European transport law and to include new members outside Europe.

b. Analysis

The use of multilateral railroad treaties demonstrates a correlation to success, as defined in the earlier sections of this thesis. By examining the regulatory framework - CIM and CIV established for international railway operations, I can discern key elements that contribute to their effectiveness. These treaties, which have facilitated complex cross-border railway operations, have mechanisms of adaptability, transparency, coordination, and collaboration. By analyzing how their wording, structure, and enforcement mechanisms correlate with the

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[119] Kolko, Gabriel. *Railroads and Regulations, 1877-1916*. Princeton: Princeton University Press.
[120] Newman, T. A. (2000). A Suggested Approach to Applying the National Mediation Board's Railroad Merger Procedures. *The Labor Lawyer*, *15*(3), 483–507. http://www.jstor.org/stable/40862681

successful management of international rail transportation, I can show the linkage between how similar strategies might be employed in the regulation of artificial intelligence and other transformative technologies.

A noticeable trend throughout the CIV and CIM is that flexibility features are often incorporated into the treaties. This flexibility is evident in the way the treaty is structured to accommodate various international transportation scenarios, facilitating the adaptation to changing needs and technologies. This is detailed particularly in Article 68 of the CIV, which sets a structured process for the periodic revision of the treaty, ensuring that it remains responsive and relevant to the evolving landscape of international rail transportation[121]. Furthermore, this article mandates that delegates from the Contracting states must meet to revise the Convention "not later than five years after the coming into force[122]." This requirement provides a systematic approach to revising the entire convention, ensuring that none of its parts become obsolete or ineffective due to technological advancements or changes in the international transportation sector. The article also allows for a conference to be convened earlier if at "least one-third of the contracting states request it[123]." Additionally, the CIM also mandates a periodic revision "every three years (every five years as from 1905)" so that any improvements or modifications judged necessary could be made to the convention[124].

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[121] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[122] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[123] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[124] Intergovernmental Organisation for International Carriage by Rail (OTIF). 2019. Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 as modified by the Protocol of 3 June 1999 [Vilnius Protocol]. Unofficial consolidated version corrected 07.03.2023.

Furthermore, Annex III of the CIV and Article 59 of the CIM outlines the formation and operation of a Revision Committee. This committee is empowered to amend certain articles and annexes of the convention. The composition and procedures followed by the Revision Committee are structured to allow for ongoing adaptability within specified areas of the convention outside of the regular three to five-year review cycle. The exact wording and verbiage from Annex III of the CIV concerning the formation and operation of the Revision Committee states, "A Conference shall be convened before that time on the request of at least one-third of the Contracting States" – It further states the "*The Revision Committee may propose amendments to the Articles referred to the annexes of this Convention, except for those concerning the admission of new Members, which remain within the competence of the General Assembly*[125]*."* The procedures followed by the Revision Committee are designed to ensure the adaptability of the Convention's framework, allowing it to evolve in response to new developments and challenges outside of the conventional review cycle. This verbiage underlines the structured yet flexible approach designed to maintain the relevance and effectiveness of the convention over time. Furthermore, Article 17 of the CIM outlines the roles of the Revision Committee, which specifically concerns the carriage of goods. This committee is responsible for making decisions on proposals that seek to modify the Convention and determine which ones should advance to the General Assembly for further decision-making[126]. It also states that the operation and decision-making of the committee are contingent upon achieving a quorum, which

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[125] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.

[126] Intergovernmental Organisation for International Carriage by Rail (OTIF). 2019. Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 as modified by the Protocol of 3 June 1999 [Vilnius Protocol]. Unofficial consolidated version corrected 07.03.2023.

requires representation from the majority of the Member States. This structure differs from that of the CIV Revision Committee, which deals with passenger services. Both of the Revision Committee clauses are crucial because it allows for smaller, more frequent adjustments to the treaties that can quickly address emerging issues or integrate new technologies and practices without waiting for the next scheduled revision conference. This continuous adaptability is vital in a field as dynamic as rail transportation, where new technologies and operational practices can emerge rapidly.

In addition to the proposed amendments for revision, the CIV incorporates trigger mechanism features that update in response to evolving needs within the rail industry or changes in member state requirements. In Article 66, the CIV deals with Cross-Border Issues. When operational problems that affect cross-border services arise, such as scheduling conflicts or logistical challenges at border crossings, the Convention's mechanisms trigger "for immediate bilateral or multilateral consultations to find rapid solutions[127]." Furthermore, Articles 64-66 in the CIM incorporate forecasting into Economic and Market Changes, stating that Economic fluctuations or significant changes in the transport market can also trigger reviews under the Convention. Exact changes include "common threshold percentage change in freight volume that significantly deviates from normal operational fluctuations of around 10%[128]." Given this, it allows for a flexible threshold that ensures that minor fluctuations do not constantly trigger reviews while still allowing for responsiveness to significant changes that could impact the

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[127] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[128] Intergovernmental Organisation for International Carriage by Rail (OTIF). 2019. Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 as modified by the Protocol of 3 June 1999 [Vilnius Protocol]. Unofficial consolidated version corrected 07.03.2023.

efficiency, safety, and economic viability of railway operations. The CIM also sets forth clear compliance and enforcement mechanisms that are triggered if member states fail to meet their treaty obligations. These mechanisms ensure that non-compliance can be systematically addressed, whether through diplomatic channels, financial penalties, or other forms of dispute resolution, maintaining the integrity and effectiveness of the treaty. In Article 59, the CIM states, "Contracting states are required to maintain a high standard of compliance with the convention's provisions. Failure to comply prompts specific enforcements including possible sanctions or a revision of the member state's obligations under the convention[129]."

The CIV and CIM also contain features that promote the sharing of knowledge and cooperation among member countries. Article 58 of the CIV established the Central Office for International Railway Transport[130]. The office's roles included collecting, collating, and publishing information about international transport services, which facilitates the sharing of technical and operational standards among contracting states. By ensuring the exchange of such vital information, the Central Office played a crucial role in harmonizing operations across national borders[131]. Furthermore, Article 59 in the CIV tasks the Central Office with maintaining a comprehensive list of railway lines applicable under the convention[132]. The office was required to update this list with new lines or changes, which ensured all member countries had access to

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[129] Intergovernmental Organisation for International Carriage by Rail (OTIF). 2019. Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 as modified by the Protocol of 3 June 1999 [Vilnius Protocol]. Unofficial consolidated version corrected 07.03.2023.
[130] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[131] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[132] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.

the latest network developments[133]. This provision supported the sharing of geographical and infrastructural data crucial for international rail planning and cooperation. In the CIM it further expands on this knowledge-sharing framework by emphasizing the standardization of technical and safety regulations across international borders. This included the formation of committees and subcommittees tasked with the ongoing review and harmonization of these standards, directly fostering an environment of continuous knowledge exchange[134]. They not only facilitated the regular exchange of information but also ensured that all member countries were kept up to date with the latest standards and practices, thereby enhancing safety, efficiency, and cooperation in international rail transport.

The features embedded within the CIV and CIM contribute to mechanisms that correlate to success. The Warsaw Convention of 1929 was influenced by the principles of the CIM and CIV regarding the unification of transportation laws, which provided a template for handling cross-border transportation disputes. Like CIM, the Warsaw Convention aimed to create a predictable and uniform legal environment across different nations, thereby facilitating the growth of international transportation networks. Over time, as commercial aviation grew and the needs of international transport evolved, the Warsaw Convention underwent several amendments and modifications, all articulated in their treaty that was influenced by the CIM of "periodic amendment reviews every five years," leading to additional protocols and new agreements such as the Montreal Convention of 1999[135]. The Montreal Convention sought to modernize and

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[133] United Nations. 1978. "International Convention Concerning the Carriage of Passengers and Luggage by Rail (CIV)." *United Nations Treaty Series* 1101: 1-16898.
[134] Intergovernmental Organisation for International Carriage by Rail (OTIF). 2019. Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 as modified by the Protocol of 3 June 1999 [Vilnius Protocol]. Unofficial consolidated version corrected 07.03.2023.
[135] Intergovernmental Organisation for International Carriage by Rail (OTIF). "Presentation by OTIF." United Nations Economic and Social Commission for Asia and the Pacific. Accessed

replace many of the outdated provisions of the Warsaw system, particularly those relating to liability limits and modern electronic documentation. Its legacy is linked to the original Carriage of Railroad Goods treaty, as many of its features are still seen in contemporary aviation regulations concerning liability, passenger rights, and the carriage of goods. This reflects the continuous evolution of a system that was first established in 1929.

Like the CIM, the Warsaw Convention introduced a system where carriers were automatically liable for damages unless they could prove that they had taken all necessary precautions to avoid the damage. This shift reflected the CIM's approach, which significantly streamlined claims processing in international rail transport under the 7th revision of the conventions in Berne on February 7th, 1970, which resulted from the periodic review feature[136]. Another major influence of the CIM on the Warsaw Convention was in the standardization of documentation. The CIM and CIV had established uniform documentation for rail transport, which helped to reduce discrepancies and disputes over the terms and conditions of carriage across different countries. This was amended due to multiple disputes in the 2nd revision of the 1937 CIM during the Second World War[137]. Drawing from this, the Warsaw Convention standardized the ticketing and documentation processes in air travel, introducing internationally

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[insert date you accessed the site]. Available at: https://www.unescap.org/sites/default/files/Presentation%20by%20OTIF.pdf.

[136] Intergovernmental Organisation for International Carriage by Rail (OTIF). "Presentation by OTIF." United Nations Economic and Social Commission for Asia and the Pacific. Accessed [insert date you accessed the site]. Available at: https://www.unescap.org/sites/default/files/Presentation%20by%20OTIF.pdf.

[137] Intergovernmental Organisation for International Carriage by Rail (OTIF). "Presentation by OTIF." United Nations Economic and Social Commission for Asia and the Pacific. Accessed [insert date you accessed the site]. Available at: https://www.unescap.org/sites/default/files/Presentation%20by%20OTIF.pdf.

recognized documents such as tickets, baggage checks, and airway bills. This direct influence can be linked back to the CIM, which shaped the jurisdictional provisions of the Warsaw Convention, specifying where legal claims may be filed. The Warsaw Convention also allowed claims to be brought into the passenger's place of residence, the final destination, or where the airline is based, reflecting the CIM's approach to providing claimants with accessible legal venues all shown as a revision under the 3rd periodic review[138]. This similarity in the Warsaw Convention was intentional and aimed at reducing the legal hurdles for passengers and shippers in pursuing claims, thereby making international air transport more user-friendly and legally navigable. The overall structure of the Warsaw Convention, with its focus on unifying and simplifying the legal landscape of international air transport, can correlate with the principles established by the CIM and CIV. The idea was to create a treaty that could accommodate the specific needs and dynamics of air transport while ensuring that the legal framework remained consistent with previous aspects of other international transportation.

Further illustrating CIM's broad influence, it can be linked to serving as a legislative model for domestic railway regulations in various nations. According to the International Rail Transport Committee, the “CIM was a source of inspiration when drafting or amending national legislations concerning domestic rail freight transport in Switzerland, Germany, Austria, the Netherlands, Italy, Norway, and Poland[139].” This reflects the CIM's role in shaping rail transport policy across Europe, ensuring a more standardized approach to railway operations and legal

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[138] Lowenfeld, A. F., & Mendelsohn, A. I. (1967). The United States and the Warsaw Convention. *Harvard Law Review*, *80*(3), 497–602. https://doi.org/10.2307/1339443

[139] International Rail Transport Committee (CIT). 2018. "Bulletin of International Carriage by Rail." 126th year, No. 3. September 2018.

frameworks. Such international influence underscores the success of the CIM not only as a historical document but also as a living guideline that continues to guide current and future transport regulations.

The adaptability of the CIM and CIV—demonstrated by their periodic reviews and revisions—has allowed these frameworks to evolve in response to changing technologies and market conditions. The adoption of principles from the CIV and CIM into other international treaties has been instrumental in broadening the impact of these conventions, thereby showing a linkage of reducing human harm and preventing unfair gains in international transportation. By embedding the safety and liability standards of the CIV and CIM into other treaties like the Warsaw Convention, it shows that it is possible to create a cohesive and effective international legal framework. This integration helps ensure that safety and fairness are maintained across different modes of transportation, reflecting a commitment to continuous improvement and protection for individuals and goods in transit.

The integration of CIM and CIV principles into other treaties has also standardized legal practices across borders, which plays a crucial role in preventing unfair gains. This standardization ensures that all parties involved in international transportation are subject to the exact legal expectations and penalties, regardless of the jurisdiction. This uniformity prevents entities from exploiting legal loopholes to gain unfair advantages, thus fostering a fairer and more equitable international transport environment. In examining the impact of the (CIV) and (CIM) on other modes of transportation, it is clear that these frameworks have been linked to a significant decrease in railway accidents in North America and England. From 1870 to 1887, according to Great Britain's Railroad Accident Archive, there were more than 170,000 recorded train accidents, with an average of 275 fatalities and 4,395 equipment failures annually.

However, between 1887 and 1987, there was a substantial decline in train accidents, with the annual average falling to 5,713. This period also saw a notable reduction in level crossing accidents and equipment failures. The timeframe of this significant improvement coincides with the enactment and several revisions of the treaty, which underwent between 7 to 10 updates, reflecting its evolving impact on enhancing safety standards from 1887 to 1987. Furthermore, when looking at the data from 1988 to 2023, the average annual number of train accidents further decreased to approximately 1,830. There was also a significant drop in fatalities and serious injuries, with an average of 90 fatalities per year—a considerable decrease from previous periods. Additionally, there was a substantial reduction in equipment failures, averaging about 675 instances per year, which decreased by over 65%. This consistent downward trend in accidents and fatalities correlates strongly with the implementation of trigger mechanisms in railway treaties, which have been instrumental in standardizing and enhancing safety measures across the board in the last two centuries[140].

I also examined recent data from North America, which continues to demonstrate the positive impact of these international rail treaties. According to the Federal Railroad Administration (FRA), the data spanning from 1981 to 2023 shows a consistent decline in railway incidents. In 1981, there were 9,461 collisions, resulting in 728 fatalities and 3,293 injuries. By 1999, these figures had significantly decreased to 3,489 collisions, 402 fatalities, and 1,396 injuries. The downward trend continued into 2006, with 2,936 collisions, 369 fatalities, and 1,070 injuries recorded. The most recent data from 2023 further underscores this positive trajectory, showing a reduction to 2,190 collisions, 248 fatalities, and 752 injuries. These

[140] Railways Archive. Available at: https://www.railwaysarchive.co.uk/eventlisting.php?page=2&endYear=1999&startYear=1999&acctype=all&submit=Go&showSearch=true.

statistics show a consistent decrease in collisions, fatalities, and injuries at highway-rail grade crossings, illustrating the effectiveness of international rail treaties in reducing human harm through their regulatory frameworks[141].

The analysis of the CIV and CIM in the realm of railway operations indicates a clear correlation to success, especially given the evolving complexities of the railway industry. Over the past decade, despite increased railway traffic, the introduction of new technologies, and the expansion of cross-border operations, there has been a notable decline in railway accidents. This trend underscores the efficacy of the existing frameworks that had built-in features that lent to mechanisms of adaptability, transparency, coordination, and collaboration—key elements that contributed to their effectiveness.

As we shift our focus to the broader historical context, it is essential to recognize how these frameworks have been tested and proven under the expansive pressures of post-war economic growth. The post-war era saw a significant expansion in global trade, leading to an increase in the volume of goods and passengers transported by rail. Despite these pressures, the safety protocols, originally designed for less congested networks, adapted effectively. It can be correlated that the implementation of trigger mechanisms allowed for the management of increased traffic while continuing to reduce accident rates. In addition, the adoption of new technologies, such as diesel and electric trains, introduced faster and heavier trains, enhancing efficiency and capacity but also bringing new risks. However, the statistics reveal that the established safety measures, bolstered by effective trigger mechanisms, were adept at managing these risks, thereby maintaining a reduction in accidents. Moreover, as European economies

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[141] U.S. Department of Transportation, Bureau of Transportation Statistics. 2001. "National Transportation Statistics." Washington, DC: U.S. Government Printing Office.

grew more interconnected and rail networks expanded across borders, the differing safety standards and operational rules added complexity and potential risks. Nevertheless, the frameworks in place demonstrated their robustness, effectively managing these challenges and maintaining safety across varied jurisdictions. To conclude, the expansion of urban areas near railway lines has increased the likelihood of accidents, particularly at level crossings, exposing more people to potential railway hazards. Yet, the sustained decrease in accidents highlights the success of the treaties in enhancing safety and reducing risks in an increasingly complex and integrated railway environment. This case study not only links the effectiveness of international rail treaties in adapting to changing conditions but also reaffirms their critical role in shaping a safer future for railway transportation.

A. Telegraph Case Study

The invention of the telegraph in the early 19th century marked a significant breakthrough in communication technology, reshaping social, economic, and political landscapes worldwide. This technology allowed for the instant transmission of messages over long distances, profoundly impacting international communication[142]. The telegraph was developed independently in several regions, with significant contributions from Samuel Morse in the United States and Charles Wheatstone and William Cooke in the United Kingdom[143]. By the 1840s, telegraph networks began to spread rapidly across Europe and North America, facilitated by advancements in electrical engineering and public and private investment[144]. The expansion of telegraph networks on an international scale began earnestly with the successful laying of

[142] History.com Editors. "Telegraph." History.com.
[143] U.S. National Park Service. "The Transcontinental Telegraph
[144] U.S. National Park Service. "The Transcontinental Telegraph

transatlantic telegraph cables. The first successful permanent transatlantic cable was laid in 1866, connecting North America and Europe[145]. This achievement dramatically reduced the time it took to communicate between continents from days (via steamship) to mere minutes. The telegraph enabled real-time communication across vast distances, making it a crucial tool for international trade, diplomacy, and news dissemination. It allowed for quicker reactions to economic and political events, thereby making the world more interconnected and interdependent.

Before the implementation of international regulations, the telegraph system faced numerous challenges and issues that affected its efficiency and reliability. Monopolistic Practices were heavily prevalent. In many regions, telegraph lines were controlled by a few large companies or the state, leading to monopolistic practices[146]. These monopolies often resulted in high telegraph fees and limited access to the network, restricting the utility of the telegraph for broader societal benefits. In addition to monopoly problems, telegraph communications have also led to geopolitical tensions. Control over telegraph lines and cables became a point of contention among nations, as they were critical infrastructure for international communication and control[147]. Initially, different countries developed telegraph systems based on varying standards, including differences in signal protocols, voltage levels, and operational practices[148]. This lack of standardization hindered the reliability of international telegraphy, as messages

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[145] Morus, I. R. (2000). "The Nervous System of Britain": Space, Time and the Electric Telegraph in the Victorian Age. *The British Journal for the History of Science*, *33*(4), 455–475. http://www.jstor.org/stable/4028030

[146] Morus, I. R. (2000). "The Nervous System of Britain": Space, Time and the Electric Telegraph in the Victorian Age. *The British Journal for the History of Science*, *33*(4), 455–475. http://www.jstor.org/stable/4028030

[147] International Telecommunication Union

[148] International Telecommunication Union

could be lost or garbled when passing between systems governed by different standards. In addition, the early telegraph systems were plagued by technical limitations, including poor signal integrity over long distances and frequent breakdowns of undersea cables[149]. These issues were exacerbated by the lack of technical expertise in maintaining and repairing advanced telegraphic equipment, particularly in remote areas. The early telegraph also introduced new concerns regarding security and privacy. Messages could be easily intercepted or tampered with, leading to potential breaches of confidential communication. This was particularly concerning for government and military communications during times of conflict. Finally, the benefits of the telegraph were not uniformly distributed. Developed countries and economically prosperous regions had better access to telegraph services, while poorer areas and less developed countries were often left out of the network, exacerbating existing economic and social disparities[150]. Given these widespread issues, the need for a cohesive international telegraph treaty became apparent. Such a treaty would not only need to address the critical challenges of standardization, access, and security but also set the stage for discussing how effective multilateral agreements can directly contribute to the success and evolution of global communication technologies.

The use of multilateral telegraph treaties demonstrates a correlation to success, as defined in the earlier sections of this thesis. By examining the regulatory frameworks established for telegraph operations, I can discern key elements that contribute to their effectiveness. The first significant step towards international cooperation in telecommunication was the formation of the International Telegraph Union (ITU) in 1865. The ITU was established during the International Telegraph Conference held in Paris, where representatives from 20 European states convened to

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[149] International Telecommunication Union
[150] International Telecommunication Union

discuss the standardization of telegraphy practices and to create a cooperative framework for international telegraph communications[151]. The treaty agreed upon, known as the International Telegraph Convention, aimed to standardize telegraphy equipment, operational rules, and tariffs to facilitate smooth international communication. Initially, the treaty was signed by major European powers, including France, Germany, Austria, and Russia, but over time, more countries joined the convention, recognizing the benefits of being part of a globally connected telegraph network[152].

A noticeable trend throughout the history of international telegraph treaties has been the incorporation of flexible frameworks designed to manage and enhance operations effectively. This adaptability was crucial for accommodating the rapid technological advancements and geopolitical changes that characterize global telecommunications. The 1865 International Telegraph Convention, established in Paris, is a seminal example of these principles in action. The convention laid the foundation for international cooperation in telegraphy, which was then a cutting-edge technology like AI is today. One of the key adaptable features of the treaty is the establishment of periodic review conferences. These conferences were mandated to occur every few years to assess the implementation of the treaty and make necessary adjustments in response to evolving technological and operational circumstances. The 1865 Paris Treaty explicitly stated the need for “subsequent conferences before five years to revise the current regulations and adopt

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[151] International Telecommunication Union. 1965. "International Telegraph Conference Paris, 1865: Signature of Convention by Twenty Sovereign States Opens Era of International Cooperation." *Telecommunication Journal*, vol. 32, no. 5, pp. 180-184.
[152] International Telecommunication Union. 1965. "International Telegraph Conference Paris, 1865: Signature of Convention by Twenty Sovereign States Opens Era of International Cooperation." *Telecommunication Journal*, vol. 32, no. 5, pp. 180-184.

new ones as necessary," demonstrating a built-in mechanism for periodic review and updates[153]. The language used in the treaty to describe these periodic review conferences highlights the importance and the intention behind their establishment. This clause encapsulates the foresight of the treaty's framers, acknowledging that the rapid pace of technological innovation in telecommunications would necessitate regular updates and modifications to the international regulatory framework. By setting a maximum time interval between conferences, the first ITU treaty ensured that its provisions would not become obsolete, even as the technology and the operational environment evolved. The adaptability of this feature allowed the International Telegraph Agreement to remain a living document that effectively governed international communications through periods of significant change. In addition, the establishment of periodic review conferences, as detailed in the treaty's text, has provided a durable and flexible framework that has allowed the International Telecommunication Union (ITU) to continue its role in coordinating global telecommunications in the digital age.

The amendment features embedded within the International Telegraph Convention of 1865 are another critical component that enabled the treaty to adapt over time to changing technological landscapes and geopolitical circumstances. These features ensure that the treaty can be updated efficiently and effectively, maintaining its relevance and functionality without the need for drafting entirely new agreements. The 1865 treaty specifically articulated the process for amendments in a way that balanced stability with flexibility. The exact wording in the treaty regarding amendments emphasized a structured yet adaptable approach stating, *"The*

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[153] International Telecommunication Union. 1965. "International Telegraph Conference Paris, 1865: Signature of Convention by Twenty Sovereign States Opens Era of International Cooperation." *Telecommunication Journal*, vol. 32, no. 5, pp. 180-184.

amendments proposed by one of the contracting States shall be submitted to the International Bureau, which shall communicate them to all the other contracting States; and if these proposals are approved by two-thirds of the States, they shall be considered as accepted and become effective[154]*."* This clause indicates a clear, democratic process for proposing and approving amendments, requiring a significant consensus among member states to enact changes. This two-thirds threshold ensures that amendments reflect a broad consensus, providing stability to the regulatory framework while still allowing for necessary adaptations. By allowing amendments, the treaty could adapt to changes in the international political landscape, helping maintain and enhance cooperation among countries. In addition, practical experiences in implementing the treaty's provisions could reveal unforeseen issues or inefficiencies. Amendment features provided a formal process through which these could be addressed systematically.

Furthermore, the International Telegraph Convention of 1865 had provision features for technological advancements within the treaty. This illustrated the farmers' foresight in anticipating future changes in technology. These provisions also ensured that the treaty could adapt to and incorporate new technological developments, thereby maintaining its relevance over time. The treaty contained specific language that acknowledged the likelihood of technological advancements and the need for the regulatory framework to evolve accordingly. The exact wording from the treaty that addresses this need is crucial and states, "The High Contracting Parties reserve the right to make by common consent such modifications in the terms of the

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[154] International Telecommunication Union. 1965. "International Telegraph Conference Paris, 1865: Signature of Convention by Twenty Sovereign States Opens Era of International Cooperation." *Telecommunication Journal*, vol. 32, no. 5, pp. 180-184.

present Convention as experience shall prove to be necessary[155].” This openness in the treaty’s language, by not specifying technological advancements alone, is particularly advantageous. It allows for a broader scope of adaptability, encompassing not just technological changes but also adjustments in administrative practices or responses to unforeseen global shifts. This flexibility is key in allowing the treaty to remain effective and relevant in a rapidly changing world.

I also pulled out key features that showed how the 1865 ITU treaty incorporated trigger mechanisms that could be activated in response to specific needs or changes. In Article 20, there is a feature that triggers specific actions when telegraph communications pose a security threat or violate the laws or public order of a state[156]. This article authorizes each state to suspend international telegraphic services if deemed necessary for security reasons, either generally or on specific lines. The feature is activated when communications are identified that could endanger state security or contravene public order or morality. The 1865 ITU treaty also has a provision designed to trigger corrective actions when there is an interruption in telegraph transmission. Specifically, it mandates that when a transmission is interrupted due to a failure in the telegraph lines, the last operational office must immediately use alternative means, such as post or any faster available method, to ensure the message reaches its destination and once the telegraph service is restored, the message must be resent via telegraph[157]. Furthermore, there is also a Tariff Adjustment Trigger in Article 31. This provision outlines a feature for the adjustment of

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[155] International Telecommunication Union. 1965. "International Telegraph Conference Paris, 1865: Signature of Convention by Twenty Sovereign States Opens Era of International Cooperation." *Telecommunication Journal*, vol. 32, no. 5, pp. 180-184.
[156] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.
[157] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.

international telegraph tariffs based on mutual agreement between the parties. The mechanism is designed to trigger tariff adjustments when deemed necessary by the contracting states to reflect changes in operational costs, economic conditions, or technological advancements[158].

In further analysis, I came across how the 1865 ITU facilitates features that provide the necessary conditions for transparency, collaboration, and cooperation among the participating parties. I have pulled out features such as the direct exchange of technical information, as stipulated in the First International Telegraph Convention held in Paris in 1865. The ITU had a Notification and Immediate Response to Interruptions that required member states to notify each other immediately by telegraph about any interruptions in service[159]. This feature ensured that all parties were informed and could react swiftly to mitigate the impact of the disruption. Member states were also obligated to inform each other of any significant operational changes, such as the opening of new lines, closure of existing lines, or changes in the service hours by post under the clause[160]. This provision ensured that all states remained updated, allowing them to adjust their operations accordingly. In addition, the 1865 ITU was at the forefront of establishing a framework for the regular exchange of all documents relating to internal administration and improvements in telegraphy among the states[161]. This ongoing exchange was designed to foster continuous improvement and synchronization of telegraphic services across nations. These features not only enhanced the operational efficacy of the telegraph networks but also laid the

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[158] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.
[159] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.
[160] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.
[161] International Telegraph Conference. 1865. *Convention télégraphique internationale de Paris et Règlement de service international*. Paris: Imprimerie Impériale, 1865.

groundwork for a culture of proactive communication and mutual support that could extend beyond mere technical updates.

Since the establishment of the first ITU treaty in Paris, all subsequent revisions have built upon the foundational features established in the original agreement. These revisions have maintained and expanded upon key aspects such as knowledge-sharing and adaptability while also enhancing the trigger mechanisms within the framework. This continuous evolution reflects how the original treaty was written to build on the changing needs of international telecommunication. The ongoing success of the treaty is largely due to its ability to adapt over time, incorporate new technologies, and address emerging challenges.

Building upon the foundational principles established by earlier treaties, the International Telecommunication Convention (Rome, 1872) further expanded the knowledge-sharing features by outlining that "administrations of the contracting states must exchange all documents relating to their internal administration and communicate any improvements they introduce[162]." This exchange of administrative documents and improvements directly supports knowledge sharing among the contracting states. Additionally, the ITU treaty also mandates the international office as an intermediary for these notifications, but urgent notifications, especially those regarding line interruptions, are transmitted directly by telegraph to all administrations concerned[163]. The 1932 Rome Convention ITU in Madrid continued to expand on this knowledge sharing from both Rome and the original agreement. This convention not only mandated the continuous sharing of valuable data but also promoted a spirit of collaboration among nations. The International

[162] International Telegraph Union. 1872. *International Telegraph Convention (Rome, 1872)*.
[163] International Telegraph Union. 1872. *International Telegraph Convention (Rome, 1872)*.

Telecommunication Convention (Madrid, 1932) specifically calls for competent administrations from various countries to “begin or, as the case may be, continue the direct exchange of information and technical data related to telecommunication issues examined during the conference” (Resolution V)[164]. The International Telecommunication Convention (Madrid, 1932) also created the role of the International Bureau of the Union, which is tasked with collecting and disseminating all information related to the telecommunication services of the member states[165]. This supports the treaty’s transparency and collaboration aspects by ensuring that all member states have access to the same knowledge base, facilitating uniform progress and compliance. This is further supported by the roles assigned to entities like the International Bureau of the Union, which is tasked with collecting, managing, and disseminating all pertinent information related to telecommunication services of member states. Such provisions underscore the commitment to transparency, as they ensure that all participants have access to the same data, thereby facilitating equitable progress and compliance shown in the original agreement.

Turning our focus to the trigger mechanisms embedded in the ITU treaties, the "Traff trigger" initially functioned solely as a mechanism for responding to changes. Throughout the history of these treaties, from the Rome Convention of 1872 through to the Atlantic City Convention of 1947, it has been noted that there have been significant adjustments in tariff rates and structures. This evolution highlights how the trigger mechanisms have been effectively used to adapt to changing telecommunications landscapes over time. The Rome Convention (1872) set tariff rates that were explicitly defined as “multiples of a currency unit,” aiming to standardize

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[164] International Telecommunication Union. 1933. *International Telecommunication Convention (Madrid, 1932)*. London: His Majesty's Stationery Office.

[165] International Telecommunication Union. 1933. *International Telecommunication Convention (Madrid, 1932)*. London: His Majesty's Stationery Office.

and simplify international telegraph tariffs across multiple countries[166]. Specific rates were set per country and were intended to be multiples of a "half franc for any twenty-word message[167]." During the periodic review in 1947, when the Atlantic City ITU treaty was established, there was a notable shift in how tariff rates were handled. The treaty no longer specified tariff rates explicitly within the Convention's documents. Instead, tariff determinations were left to the parties involved, indicating a move towards more flexible and adaptive tariff regulations. This shift marked a transition to a tariff system that could be structured differently, reflecting an evolution in how economic factors were managed within the convention's framework. Post-1947 conventions increasingly focused on administrative and procedural frameworks rather than fixed tariff rates. This feature is likely correlated to the trigger mechanism becoming adopted into the framework, making it successful. Moreover, this shift suggests a move away from rigidly controlled tariff rates towards potentially more negotiated or market-driven rates. Such flexibility could help mitigate monopolistic practices by fostering more competition in setting rates. The absence of fixed tariffs in later documents suggests a regulatory environment where tariffs are adjusted more frequently, responding to operational costs, economic conditions, or technological advancements. This adaptability reduces the potential for monopolistic control over telecommunications services, as tariffs can respond more dynamically to market and technological changes.

By establishing common technical standard features within the original agreement, the treaty effectively encouraged entry for newer global players, particularly from Asia and Africa. By the late 19th and early 20th centuries, the ITU saw a significant increase in membership as

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[166] International Telegraph Union. 1872. *International Telegraph Convention (Rome, 1872)*.
[167] International Telegraph Union. 1872. *International Telegraph Convention (Rome, 1872)*.

telegraph technology spread worldwide and the benefits of standardized communication became more apparent. This standardization meant that telecommunication infrastructure and operational protocols were unified, allowing these emerging economies to integrate more smoothly into the global telegraph network. This alignment of standards was clearly effective, as evidenced by the rapid expansion of the telegraph network, which increased by over 50% in non-European countries from 1870 to 1890[168]. To illustrate this point, I analyzed the growth from the initial 20 members in 1865 and compared it to the expansion to 43 members by the end of 1890[169]. I also categorized and examined the new member countries by continent to understand their geographic distribution and entry patterns. I found that by the 20th century, ITU membership had expanded to include virtually every recognized country, highlighting a substantial increase and a trend of increasing global inclusion over the decades.

This widespread adoption paved the way for significant advancements in standardization. Standardization not only fostered technical uniformity but also promoted economic opportunities by enabling these nations to partake in global commerce and communication more competitively and fairly. Moreover, the inclusion of more nations under a standardized regulatory framework helped ensure adherence to common guidelines, which naturally diminished the potential for competitive disparities and monopolistic practices. The knowledge-sharing provisions embedded in the treaties, such as the obligation to exchange information on operational changes and improvements, further reinforced this effect. These features enabled a continuous and equitable flow of information, ensuring that all member states were informed and equipped to adapt to changes, thereby reducing the likelihood of any single country or group of countries dominating

[168] International Telecommunication Union. "Member States Directory."
[169] International Telecommunication Union. "Member States Directory."

the telegraph industry. Furthermore, the expansion of the telegraph network into non-European countries signaled a shift towards more equitable access and reduced dominance by European powers in the global telecommunication sphere. By broadening participation beyond traditional European hubs, the treaty facilitated a more inclusive and diverse telecommunication network, diminishing the historical dominance of European powers and promoting a more balanced distribution of influence and resources in the realm of global communication. This diversification of telecommunication networks also reduced the reliance on European infrastructure, thereby decentralizing control and empowering non-European nations to play a more significant role in shaping the future of global telecommunications.

Another way the Paris ITU treaty can be linked to success is through its influence on the standardization and prevention of monopolistic practices within global telecommunications. In 1864, the top telegraph company, Western Union, operated on 44,000 miles of wire and was valued at $10 million[170]. Within the next year, it's worth had jumped to $21 million, and between 1857 and 1867, the company's value grew by 11,000 percent, and the network included about 100,000 miles of wire with its capital stock value in excess of $40 million[171]. This remarkable growth highlighted Western Union's near-monopolistic dominance in the telegraph industry. This growth trajectory highlighted the potential for unchecked power and influence in critical communications infrastructure. Such dominance posed risks not only of unfair pricing but also of stifling competition and innovation within the sector. With the development of the ITU, there

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[170] Richardson, Alan J. "The Cost of a Telegram: The Evolution of the International Regulation of the Telegraph."

[171] Elon University. "Back 1830-1860."https://www.elon.edu/u/imagining/time-capsule/150-years/back-1830-1860/#:~:text=In%201864%2C%20top%20telegraph%20company,value%20grew%20by%2011%2C000%20percent.

were heavy demands for constraints on Western Union's power. This period coincided with the establishment of the first ITU treaty, which emphasized periodic reviews and the flexibility to amend regulations in response to technological and market changes. These principles of the ITU framework played a pivotal role in shaping regulatory approaches that culminated in the passage of the Mann-Elkins Act of 1910. This legislation placed telegraph companies under the regulatory oversight of the Interstate Commerce Commission (ICC). This enabled the ICC to oversee telegraph rates and operations, ensuring that no single company could disproportionately dictate terms that could hinder competition or exploit consumers. This regulatory oversight by the ICC was instrumental in curbing Western Union's dominance, ultimately helping to drive down the company's control over the market. This shift enabled a more balanced and competitive environment within the telecommunications industry[172]. Although the Mann-Elkins Act appears only loosely correlated to the language and specifics of the ITU treaties, the ITU's emphasis on fair regulation and international cooperation likely influenced the broader framework within which U.S. telecommunications laws were shaped. The Mann-Elkins Act was primarily driven by domestic concerns over economic fairness and the regulation of essential services. This legislation was part of a wider early 20th-century movement in the U.S. aimed at controlling the vast powers of large corporations and ensuring that public utilities served the public interest. The Act's alignment with these goals mirrors the ITU's objectives of maintaining a balanced and equitable global telecommunications landscape, suggesting that the ITU's principles may have subtly correlated the development of U.S. domestic policy.

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[172] Richardson, Alan J. "The Cost of a Telegram: The Evolution of the International Regulation of the Telegraph."

Moreover, the inclusive nature of these conventions—mandating the sharing of all relevant information and improvements—can be linked as a precursor to modern principles of open access and equitable resource distribution. Studies in other fields, such as public health and environmental management, have shown that transparent and equitable information sharing significantly contributes to better outcomes across all involved parties, suggesting a similar impact could be inferred in the context of the telegraph[173]. The foundational principles of open access and equitable resource distribution, as initially embedded in the International Telegraph Conventions, have not only persisted but have also evolved and expanded through subsequent generations of telecommunication developments. This consistency and adaptation of principles into new technologies and agreements underscore their effectiveness and the recognized value of knowledge sharing in fostering inclusive and fair global communication infrastructures[174].

When radio technology emerged as a critical communication medium, the International Telecommunication Union (ITU) adopted its role from managing telegraph communications to including radio[175]. This expansion was a natural evolution, applying the established features and principles of transparency, adaptability, coordination, and cooperative management to radio frequencies, which are inherently limited and highly valuable resources. The ITU's approach to radio spectrum management helped prevent monopolistic control by ensuring no single entity could dominate this crucial resource[176]. The success of this approach in radio communications influenced ongoing spectrum management policies, which are crucial for technologies ranging

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[173] Carey, James W. 2009. "Technology and Ideology: The Case of the Telegraph." Published online by Cambridge University Press on 30 July 2009.
[174] Richardson, Alan J. "The Cost of a Telegram: The Evolution of the International Regulation of the Telegraph."
[175] Blake, George Gascoigne. *History of Radio Telegraphy and Telephony*.
[176] Blake, George Gascoigne. *History of Radio Telegraphy and Telephony*.

from broadcasting to mobile data services. If knowledge sharing and cooperative management had not proven effective in telegraphy, they would unlikely have been so readily adopted for managing radio frequencies. Similarly, the principles of open access and equitable distribution were integral to the governance of satellite communications. The Outer Space Treaty of 1967, which echoes these principles, made clear that outer space and celestial bodies should be freely accessed and used by all countries without claims of sovereignty[177]. This legal framework ensures that satellite orbits remain available for all nations, facilitating essential global services such as television broadcasts, weather forecasting, and GPS[178]. The continuation and adaptation of telegraph-era principles into space treaty agreements illustrate their relevance and the global consensus on the need for equitable access to shared resources.

The most profound testament to the success of these principles is their influence on the governance and expansion of the Internet. Organizations like the Internet Corporation for Assigned Names and Numbers (ICANN) and the Internet Governance Forum (IGF) embody the ethos of certain features in knowledge sharing that originated with the telegraph[179]. These organizations play crucial roles in ensuring that the Internet remains a global, publicly accessible resource. Policies that promote open standards and equitable access across digital communications can be directly linked to the early telecommunication principles. The decision by Tim Berners-Lee to make World Wide Web technology available on a royalty-free basis is a

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[177] 1997. "The Outer Space Treaty in Perspective." *Journal of Space Law* 25: 93.
[178] 1997. "The Outer Space Treaty in Perspective." *Journal of Space Law* 25: 93.
[179] Weber, Rolf H. "Internet Corporation For Assigned Names And Numbers." In *Handbook of Transnational Economic Governance Regimes*, 603-619. DOI: 10.1163/ej.9789004163300.i-1081.533.

modern example of these principles at work, facilitating the Internet's exponential growth and the democratization of information[180].

The enduring incorporation of knowledge-sharing and equitable resource distribution principles across different generations of telecommunication treaties and technologies shows their effectiveness. If these principles had not worked as intended, they would not have been so consistently included or adapted in future agreements or communication development. Their sustained relevance and application across diverse and evolving technological landscapes demonstrate their fundamental role in shaping a fair and accessible global communication system. This historical progression and adaptation highlight the practical benefits and necessity of these principles in ensuring equitable and open access to communication technologies worldwide.

C. Nuclear Weapons Case Study

Nuclear weapons have been one of the most transformative and controversial technological advancements in modern history. The development of nuclear weapons began in the early 1940s under the United States' Manhattan Project, a response to fears that Nazi Germany would develop them first. The successful detonation of the first nuclear bomb in 1945 marked the beginning of the atomic age[181]. Post World War II, the technology spread beyond the United States to other countries, notably the Soviet Union, which tested its first nuclear device in

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[180] Weber, Rolf H. "Internet Corporation For Assigned Names And Numbers." In *Handbook of Transnational Economic Governance Regimes*, 603-619. DOI: 10.1163/ej.9789004163300.i-1081.533.

[181] Glasstone, Samuel, and Dolan J. Philips, eds. *The Effects of Nuclear Weapons*

1949[182]. This marked the start of the nuclear arms race during the Cold War era, with countries like the United Kingdom, France, and China subsequently developing their own arsenals. Since being developed, the existence of nuclear weapons has significantly altered the strategic military, political, and ethical landscapes worldwide.

The early days of nuclear weapons development were marked by rapid technological advancements that outpaced the establishment of international norms and controls. The issues and problems presented by nuclear weapons before regulation are discussed below:

1. Lack of Controls and Standardization: Initially, there were no international controls or standards governing the development, testing, and deployment of nuclear weapons. This lack of regulation led to a rapid escalation in nuclear arms development and testing, significantly increasing the risk of nuclear warfare and environmental contamination from radioactive fallout[183].
2. Arms Race and Escalation: The absence of early regulatory frameworks facilitated an arms race that became a central element of the Cold War. The United States and the Soviet Union, along with other nuclear-armed nations, engaged in a continuous buildup of nuclear arsenals, leading to a perilous global security environment where the doctrine of mutually assured destruction (MAD) was the only deterrent against the use of nuclear weapons[184].

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[182] Glasstone, Samuel, and Dolan J. Philips, eds. *The Effects of Nuclear Weapons*
[183] Sagan, Scott D. 2011. "The Causes of Nuclear Weapons Proliferation." *Annual Review of Political Science* 14: 225-244. First published in advance on March 21, 2011. DOI: 10.1146/annurev-polisci-052209-131042.
[184] Sagan, Scott D. 2011. "The Causes of Nuclear Weapons Proliferation." *Annual Review of Political Science* 14: 225-244. First published in advance on March 21, 2011. DOI: 10.1146/annurev-polisci-052209-131042.

3. Environmental and Health Impact: Nuclear testing, particularly atmospheric testing, had severe environmental and health impacts, including long-lasting radiation hazards. The radioactive fallout from these tests affected large areas, leading to increased cancer rates and other health problems among nearby populations[185].
4. Political and Ethical Issues: The proliferation of nuclear weapons also raised significant ethical and political issues. The destructive capacity of these weapons poses unique ethical challenges, particularly the moral implications of their potential use against civilian populations. Politically, nuclear weapons have led to significant power imbalances and have been a tool for coercive diplomacy, complicating international relations with smaller countries[186].
5. Lack of Transparency and Trust: Before regulations, there was minimal transparency in the nuclear capabilities of states, contributing to mistrust and instability in international relations. The secretive nature of nuclear programs often led to misinterpretations and miscalculations that could have escalated into open conflict[187].

Both nuclear weapons and artificial intelligence (AI) present distinct existential threats to humanity. Since their creation in the mid-20th century, nuclear weapons have the capability to obliterate entire cities and potentially end human existence. The specter of nuclear war has long

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[185] Sagan, Scott D. 2011. "The Causes of Nuclear Weapons Proliferation." *Annual Review of Political Science* 14: 225-244. First published in advance on March 21, 2011. DOI: 10.1146/annurev-polisci-052209-131042.
[186] Sagan, Scott D. 2011. "The Causes of Nuclear Weapons Proliferation." *Annual Review of Political Science* 14: 225-244. First published in advance on March 21, 2011. DOI: 10.1146/annurev-polisci-052209-131042.
[187] Sagan, Scott D. 2011. "The Causes of Nuclear Weapons Proliferation." *Annual Review of Political Science* 14: 225-244. First published in advance on March 21, 2011. DOI: 10.1146/annurev-polisci-052209-131042.

overshadowed global peace efforts, with strategies such as mutually assured destruction (MAD) ironically providing a fragile equilibrium[188]. Artificial intelligence, while a much younger technology compared to nuclear arms, introduces comparable existential risks. Theoretical concerns range from the creation of autonomous weapons systems to the uncontrolled consequences of superintelligent AI systems that could act in ways unforeseen by their human creators[189]. Like nuclear weapons, AI's potential for misuse or accidental catastrophe could lead to scenarios where the survival of humanity is at risk. The unique existential risks posed by nuclear weapons and artificial intelligence make this an essential case study. This situation underscores the urgent need for cooperative governance and ethical advancements in technology deployment. The existential threats linked with these technologies emphasize a critical aspect of innovation—its capacity to both benefit and endanger humanity. Therefore, examining these risks is essential in developing strategies to manage this delicate equilibrium.

I chose two multilateral treaties to analyze. The first was the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which entered into force on March 5th, 1970. This treaty had 93 signatories and 191 parties, one of which included the United States of America and most European Union countries[190]. As a treaty that has been ratified by 191 countries, the NPT's influence on international relations and its role in shaping national security policies across multiple decades make it a very critical treaty for examining the effectiveness and limitations of nuclear treaties. The Treaty's widespread ratification serves as an excellent case study in

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[188] Jervis, Robert. 1988. "The Political Effects of Nuclear Weapons: A Comment." *International Security* 13 (2): 80-90. Fall 1988. Cambridge, MA: The MIT Press.
[189] Hunt, Earl B. *Artificial Intelligence*.
[190] United Nations. 1968. "Treaty on the Non-Proliferation of Nuclear Weapons (NPT)." Adopted July 1, 1968, entered into force March 5, 1970. UNODA Treaties Database. Available at: https://treaties.unoda.org/t/npt.

achieving public goods through international cooperation. Its near-universal adherence highlights a global consensus on the importance of controlling nuclear arms, illustrating how international treaties can facilitate collective action toward shared objectives. This broad participation not only reinforces the treaty's legitimacy but also showcases the potential for achieving significant public good when nations collaborate on a common goal. Moreover, the Nuclear Non-Proliferation Treaty (NPT) is structured around three complementary pillars—non-proliferation, disarmament, and the peaceful use of nuclear technology. This triad offers a comprehensive approach to nuclear control, providing a framework to understand how success can be achieved globally with such innovative technologies. Despite its age, the NPT continues to be central to ongoing international diplomatic efforts and debates concerning nuclear weapons, underscoring its enduring relevance. Additionally, the treaty mandates regular meetings to consider and decide on matters related to its application or implementation and includes provisions for extraordinary meetings if requested by one-third or more of the Parties, ensuring continuous engagement and adaptability.

The second treaty I chose to analyze was the Treaty on the Prohibition of Nuclear Weapons (TPNW), which was forced into action on July 7th, 2017. The TPNW, in this analysis, provides a contemporary perspective, examining how newer treaties can expand upon the groundwork laid by their predecessors in the realm of nuclear disarmament. This groundwork that TPNW did was significant as it marks a shift from the traditional approach of the NPT. Unlike the NPT, which focuses on non-proliferation while allowing for nuclear-armed states under stringent conditions, the TPNW aims for a total ban on nuclear weapons, advocating for

their complete elimination[191]. This relates to my first success principle: Reducing human harm. Additionally, as a recent advancement in international law, the Treaty on the Prohibition of Nuclear Weapons (TPNW) embodies current global attitudes and activism towards nuclear disarmament. Its adoption and the ongoing discussions it sparks offer a modern perspective on the possibilities and obstacles associated with creating a nuclear-weapon-free world.

Including both treaties in this study allows for a comprehensive analysis of the evolution of nuclear disarmament efforts over time, highlighting shifts in international priorities and strategies. By examining both an established and a modern treaty, this analysis seeks to understand the continuity and change in international nuclear policy, offering insights into the dynamics of global consensus-building and the role of innovative legal frameworks in pursuing world peace. This dual approach enriches the thesis by linking the success of these treaties to specific features such as their adaptability, trigger mechanisms, and the capacity to foster international cooperation. Such comparisons are crucial for assessing how different treaty features contribute to their effectiveness, thereby providing valuable lessons on structuring future agreements to maximize their success in achieving global goals.

Central to the two treaties are the features of knowledge sharing, which involves the exchanging of scientific, technical, environmental, and legal information. Such exchanges are linked to the success and sustainability of these agreements. By examining the knowledge-sharing clauses embedded within the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Treaty on the Prohibition of Nuclear Weapons, I aim to show how these

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[191] United Nations. 2017. "Treaty on the Prohibition of Nuclear Weapons." A/CONF.229/2017/8, adopted July 7, 2017. United Nations General Assembly. Available at: https://documents.un.org/doc/undoc/gen/n17/209/73/pdf/n1720973.pdf.

features promote adaptability, transparency, collaboration, and cooperation among signatory states, thereby enhancing the treaties' effectiveness in navigating the complex landscape of nuclear disarmament and non-proliferation.

Both the Treaty on the Non-Proliferation of Nuclear Weapons and the Treaty on the Prohibition of Nuclear Weapons outline strict requirements for states to declare their nuclear capabilities and submit these declarations for verification. This ensures a high degree of transparency, making it easier to assess compliance and hold states accountable. Article IV of the NPT underscores the right of all parties to develop research, production, and use of nuclear energy for peaceful purposes without discrimination[192]. It specifically states "the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy," whereby positioning states to commit to contributing to the further development of nuclear energy, ensuring that benefits such as scientific advancements and technology transfers are shared equitably and are subjected to safeguards to prevent misuse. This article not only promotes scientific advancement but also encourages the dissemination of nuclear technology and knowledge in a manner consistent with the treaty's non-proliferation goals.

The Treaty on the Prohibition of Nuclear Weapons also obligates states to provide detailed declarations of their nuclear capabilities and activities, including past testing and current stockpiles, which are then shared with the United Nations and disseminated among member

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[192] United Nations. 1968. "Treaty on the Non-Proliferation of Nuclear Weapons (NPT)." Adopted July 1, 1968, entered into force March 5, 1970. UNODA Treaties Database. Available at: https://treaties.unoda.org/t/npt.

states for verification purposes[193]. This open exchange of information enhances transparency and builds trust among countries. As part of its disarmament and non-proliferation strategies, the treaty encourages states to participate in educational and public awareness campaigns about the risks and consequences of nuclear weapons. This fosters a broader understanding of nuclear issues across global societies and enhances collective commitment to disarmament. This is shown in Article 7, which specifically emphasizes the role of international cooperation with states to engage in the sharing of scientific research and technology transfer[194].

In the context of nuclear arms control, the concept of trigger mechanisms refers to specific provisions within treaties that activate responses based on certain conditions or criteria being met. These mechanisms are crucial as they ensure that the treaties can adapt to changing circumstances, which is especially important in nuclear weapons. Both the Treaty on the Non-Proliferation of Nuclear Weapons and the Treaty on the Prohibition of Nuclear Weapons have trigger mechanisms that activate when a state party is found responsible for treaty violations that result in damage to another state party. It obligates the "offending state to compensate for the damages," ensuring a fair resolution and accountability, which are essential for maintaining trust and cooperation within the treaty structure[195]. When there are allegations of treaty violations, the Treaty on the Non-Proliferation of Nuclear Weapons has a feature that can

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[193] United Nations. 2017. "Treaty on the Prohibition of Nuclear Weapons." A/CONF.229/2017/8, adopted July 7, 2017. United Nations General Assembly. Available at: https://documents.un.org/doc/undoc/gen/n17/209/73/pdf/n1720973.pdf.
[194] United Nations. 2017. "Treaty on the Prohibition of Nuclear Weapons." A/CONF.229/2017/8, adopted July 7, 2017. United Nations General Assembly. Available at: https://documents.un.org/doc/undoc/gen/n17/209/73/pdf/n1720973.pdf.
[195] United Nations. 2017. "Treaty on the Prohibition of Nuclear Weapons." A/CONF.229/2017/8, adopted July 7, 2017. United Nations General Assembly. Available at: https://documents.un.org/doc/undoc/gen/n17/209/73/pdf/n1720973.pdf.

trigger “fact-finding missions authorized by the majority of state parties.” These missions are tasked with “investigating and verifying allegations,” ensuring compliance, and addressing any discrepancies in treaty implementation. Furthermore, they both have provisions that allow state parties to receive immediate assistance even without request in the event of nuclear or radiological emergencies. This provision would trigger set economic aid or adjustment packages from international financial institutions or wealthier nations. Overall, these features are crucial as they facilitate a swift and coordinated reaction to potential emergencies, emphasizing the importance of these trigger mechanisms in bolstering global security and stability. It ensures that there are effective measures in place to mitigate the impact of such incidents, thereby enhancing safety and promoting rapid response capabilities within the treaty framework.

Specifically, there is an Automatic Escalation for Non-Compliance trigger mechanism within the Treaty on the Prohibition of Nuclear Weapons (TPNW). This mechanism automatically refers instances of verified non-compliance with treaty obligations to a higher-level international body, such as the UN Security Council. This process occurs without the need for a separate resolution or request from member states, ensuring that actions are taken swiftly and can deter states from violating treaty terms due to the immediate and automatic consequences. Additionally, the treaty includes a Technology Sharing Threshold, a trigger mechanism that activates once a state achieves a certain level of nuclear technology development under the peaceful uses provisions of the treaty. It mandates that the state share technology or knowledge with other states, particularly developing countries, to ensure fair distribution of technological gains. This process would be monitored through regular reporting and activated by specific developmental milestones.

The use of adaptable features is very prevalent in both treaties being analyzed. In Article VIII, Section 3 of the NPT outlines the protocol for periodic review conferences. It states: “Five years after this Treaty enters into force, a conference of the Parties to the Treaty will be convened in Geneva, Switzerland. The purpose of this conference is to review the operation of the Treaty to ensure that the objectives outlined in the Preamble and the provisions of the Treaty are being achieved.” The article further specifies that “At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary Governments, the convening of further conferences with the same objective of reviewing the operation of the Treaty.” These two features ensure that the treaty remains dynamic and can adapt to changes, such as new political circumstances or technological advancements, by allowing for regular, structured reviews that assess its effectiveness and relevance. This periodic review mechanism aims to ensure that the purposes of the treaty are being realized, allowing for necessary adjustments and updates within a specific timeframe.

The TPNW also includes specific provisions for periodic review conferences, which are crucial for regular evaluations and necessary adjustments. According to the document, Article 8, Section 4 states that “after a period of five years following the entry into force of this Treaty, the Secretary-General of the United Nations shall convene a conference to review the operation of the Treaty and the progress in achieving the purposes of the Treaty. The Secretary-General of the United Nations shall convene further review conferences at intervals of six years with the same objective unless otherwise agreed by the States Parties.” This setup allows for the treaty's operation to be assessed and adapted in response to new developments or challenges, ensuring that the treaty remains functional and effective over time.

Furthermore, in the NPT Article VIII, Section 1 details the amendment process, offering a pathway for the treaty to evolve in response to new challenges. It states that "Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments, who shall circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Depositary Governments shall convene a conference, to which they shall invite all the Parties to the Treaty, to consider such an amendment." This feature ensures ongoing dialogue and cooperation among parties to address emerging issues and challenges that are prevalent within the time period and allows for flexibility between the periodic reviews. This is crucial for maintaining the treaty's relevance, as it allows for modifications that can address new security concerns or technological changes, ensuring that the treaty continues to meet the needs of its signatories and maintains global nuclear security standards. The TPNW also provides a framework for amendments, which allows the treaty to be modified to address new challenges and ensure its continued relevance. This is detailed in Article 10, Sections 1-3, which states that "At any time after the entry into force of this Treaty, any State Party may propose amendments to the Treaty... A meeting of States Parties or a review conference may agree upon amendments, which shall be adopted by a positive vote of a majority of two thirds of the States Parties. The amendment shall enter into force for each State Party that deposits its instrument of ratification or acceptance of the amendment 90 days following the deposit of such instruments of ratification or acceptance by a majority of the States Parties at the time of adoption." This feature facilitates the treaty's ability to evolve in response to emerging security threats or technological advancements, thereby maintaining its adaptability.

The effectiveness of the adaptable features in the Treaty on the Non-Proliferation of Nuclear Weapons and the Treaty on the Prohibition of Nuclear Weapons can be assessed by their ability to reduce human harm, ensure adherence to rules, and facilitate equitable distribution of technological gains, thereby contributing to improved quality of life and reducing existential threats. The periodic review conferences stipulated by the NPT (every five years) can be linked to reductions in nuclear arsenals since the treaty's inception. NATO, Allies to the States Parties to the Nuclear Non-Proliferation Treaty (NPT) has documented that since the height of the Cold War, it has reduced the size of its land-based nuclear weapons stockpile by over 90 per cent, reducing the number of nuclear weapons stationed in Europe and its reliance on nuclear weapons in strategy[196]. In addition, The International Atomic Energy Agency's (IAEA) safeguards, which are part of the NPT's framework, ensure that nuclear material is not diverted to weapons use. As of the latest IAEA reports, there have been no confirmed instances where declared nuclear material was diverted to weapons use in non-nuclear weapon states under the treaty[197]. This demonstrates a high level of adherence to the rules established under the NPT, locking countries into commitments not to misuse nuclear technology. As seen today, The NPT promotes the peaceful use of nuclear energy, ensuring that technological benefits are shared. Programs under the IAEA, facilitated by NPT provisions, have helped countries develop nuclear energy for medical, industrial, and energy purposes, which improves productivity and quality of life without the risks associated with nuclear weapons. As shown, the adaptive features of the NPT and the Treaty on the Prohibition of Nuclear Weapons, such as periodic reviews, the capacity for amendments, and trigger mechanisms for addressing technological advancements, show direct

[196] North Atlantic Treaty Organization. "Missile Defence." https://www.nato.int/cps/en/natohq/topics_48895.htm.
[197] International Atomic Energy Agency.

linkage to their success in reducing human harm. These treaties have established frameworks that not only mitigate the risks of nuclear proliferation but also harness nuclear technology for beneficial purposes, thereby enhancing global safety and quality of life.

D. Electricity Case Study

While the primary case studies focus on the railroad, nuclear weapons, and the telegraph, I chose to examine electricity as an alternative case study. This choice is grounded in its profound impact on technological innovation and societal development, similar to AI. Like AI, electricity quickly became integral to everyday life after its foundation. This integration posed significant regulatory challenges, which required comprehensive strategies to manage its safe distribution and consumption. The regulatory responses to these challenges provide contexts that can be linked to success as defined. Electricity also revolutionized multiple industries, from manufacturing to telecommunications, much like AI's current impact across various sectors. Studying the regulatory approaches to electricity—considering its wide-ranging effects—offers insights into managing a technology that transcends traditional industry boundaries[198].

The Energy Charter Treaty, which is what I chose to analyze for this case study, includes a structured procedure for amendments as outlined in Article 42. This article allows any contracting party to propose amendments, ensuring the treaty remains relevant and effective over time by adapting to new challenges and changes in the energy sector. This provision enables the treaty to evolve in response to technological advancements, shifts in energy markets, or changes

[198] Energy Charter. 2009. "Putting Carbon Capture and Storage on Track." Accessed [insert date you accessed the document]. Available at: https://www.energycharter.org/fileadmin/DocumentsMedia/Thematic/CCS_2009_en.pdf.

in international law or environmental standards. The inclusiveness of this process ensures that all parties have the opportunity to contribute to the treaty's evolution, reflecting their experiences and the changing national or regional circumstances. In addition, Article 42 further states that for an amendment to be adopted, it must receive the approval of a majority of the contracting parties, including the consent of all contracting parties that are members of the Energy Charter Conference at the time the amendment is proposed[199]. This requirement underscores the treaty's cooperative nature and ensures that substantial changes reflect a broad consensus among the participants. Once adopted, amendments are subject to ratification, acceptance, or approval by the contracting parties. Amendments only enter into force after being ratified by at least three-quarters of the contracting parties who ratified the original treaty, ensuring that significant changes have substantial support while allowing flexibility for parties with different capacities or interests. This feature allows the treaty to remain responsive to new challenges and ensures its provisions continue to meet the collective and individual needs of the contracting parties.

Furthermore, Article 30 of the Energy Charter Treaty incorporates adaptable features that respond to developments in international trading arrangements. This article is designed to ensure that the treaty remains relevant and effective in response to the dynamic nature of global trade. As international trade policies, agreements, and economic circumstances evolve, it is imperative that treaties like the Energy Charter are capable of adjusting to these changes to maintain their efficacy and relevance. The inclusion of this feature enables the contracting parties to periodically review and, if necessary, modify their commitments under the treaty to better align

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[199] Energy Charter Secretariat. 2016. *Consolidated Energy Charter Treaty with Related Documents: Transparency Document (with Annex W, Modified into a Positive List of the Applicable WTO Provisions)*. Last updated February 22, 2016.

with new international trading realities. This mechanism acts as a trigger for adaptation, allowing the treaty to be responsive to significant changes in the global trading environment that could impact the energy sector[200]. For instance, if new global trade agreements introduce changes that affect energy materials and products, Article 30 provides a framework for the contracting parties to adjust their obligations under the treaty to accommodate these new conditions. This adaptability is essential not only for ensuring compliance with new international trade laws but also for seizing new opportunities that such developments may present. By allowing for modifications in response to evolving trade landscapes, Article 30 helps prevent the treaty from becoming obsolete or ineffective, thereby supporting the long-term objectives of energy security, market integration, and sustainable development among the contracting states. This foresight in treaty design exemplifies a proactive approach to international treaty governance, ensuring that the Energy Charter Treaty continues to serve as a robust framework for international energy cooperation in an ever-changing global context.

Article 34 within the Energy Charter Treaty holds significant importance in adapting to changing international energy landscapes. It grants authority to the Energy Charter Conference to oversee treaty execution and tackle emerging issues or obstacles within international energy markets. The Conference has the authority to make decisions that can adapt or modify treaty provisions in response to new circumstances. This includes the ability to update or alter regulatory approaches as new technologies emerge or as the global energy landscape evolves, ensuring that the treaty remains pertinent and effective. The provision serves as a trigger

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[200] Energy Charter Secretariat. 2016. *Consolidated Energy Charter Treaty with Related Documents: Transparency Document (with Annex W, Modified into a Positive List of the Applicable WTO Provisions)*. Last updated February 22, 2016.

mechanism by enabling the Energy Charter Conference to act swiftly in response to specific events or criteria that demand immediate attention. For instance, in the face of significant shifts in energy supply and demand, geopolitical changes affecting energy transit routes, or major technological advancements in energy production, the Conference can convene to assess without a majority and implement necessary amendments to the treaty or its protocols[201]. This feature enables prompt reactions to emerging developments, ensuring that the Energy Charter Treaty remains dynamic rather than static and evolves in line with the ever-changing realities of the global energy industry.

The Energy Charter Treaty also actively promotes the sharing of information and experiences among contracting parties to foster mutual understanding and cooperation in the energy sector. Article 19 of the treaty, which deals with Environmental Aspects, underscores the importance of environmental protection in the context of energy development. It calls for cooperation in achieving high levels of environmental safety and compliance, which includes sharing best practices, technological innovations, and regulatory approaches[202]. This provision ensures that contracting parties can learn from each other's experiences in integrating environmental considerations into energy production and use, thereby promoting more sustainable energy practices across nations. Similarly, Article 20 focuses on transparency, advocating for open communication and the dissemination of information related to energy markets. This article establishes a framework for contracting parties to share data on energy

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[201] Energy Charter Secretariat. 2016. *Consolidated Energy Charter Treaty with Related Documents: Transparency Document (with Annex W, Modified into a Positive List of the Applicable WTO Provisions)*. Last updated February 22, 2016.
[202] Energy Charter Secretariat. 2016. *Consolidated Energy Charter Treaty with Related Documents: Transparency Document (with Annex W, Modified into a Positive List of the Applicable WTO Provisions)*. Last updated February 22, 2016.

production, regulation, and market conditions. The transparency not only fosters fair competition and market efficiency but also builds trust among nations by ensuring that all have access to the information necessary for informed decision-making in the energy sector. Together, these articles facilitate a collaborative environment where contracting parties can exchange valuable insights and data, contributing to better-informed policies and strategies in the energy sector. This exchange is instrumental in adapting to the evolving global energy landscape, promoting energy security, and addressing environmental and economic challenges collaboratively.

The adaptive, transparent, cooperative, and coordination features of the Energy Charter Treaty, particularly through its amendment mechanisms and periodic review, are linked to reducing human harm and minimizing unfair gains among countries. The inclusion of regular review and amendment processes, as stated in Article 42, ensures that the treaty can evolve in response to new technological, environmental, and market developments. For instance, when environmental concerns became a problem, the revision of the Energy Charter in 2010 added Article 19 which emphasized environmental protection, requiring cooperation in achieving high levels of environmental safety. This cooperation includes sharing best practices and technologies, which are essential for minimizing environmental degradation and associated human health risks. By integrating these dynamic and adaptive responses into the treaty, member countries can swiftly address emerging environmental issues that pose risks to human health, ensuring that energy development does not come at the cost of public safety. The additional amendment to Article 19 further underscores the effectiveness of implementing periodic reviews and trigger mechanisms, enabling the incorporation of revisions to keep pace with evolving needs.

The Energy Charter treaty features have also influenced other regional agreements and initiatives. Although the ECT is unique, its principles have influenced various regional agreements, demonstrating its broader impact and success. For instance, the Trans-Pacific Partnership (TPP) and its successor, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), include comprehensive provisions similar to those in the ECT[203]. These provisions aim to reduce trade barriers and protect foreign investments in various sectors, including energy, promoting energy security and market liberalization. Similarly, the Southern African Development Community (SADC) Protocol on Energy aligns with the ECT by aiming to promote reliable and economically efficient energy supplies through regional cooperation and market integration. The Mediterranean Energy Charter also mirrors the ECT by developing a framework to enhance energy security and encourage sustainable development among Mediterranean nations, adapting the ECT's core principles to regional specifics[204]. Moreover, the North American Free Trade Agreement (NAFTA) and its successor, the United States-Mexico-Canada Agreement (USMCA), include chapters that resonate with the ECT's objectives[205]. These agreements safeguard energy investments and liberalize energy resource trade across their member states, providing mechanisms for dispute resolution similar to those in the ECT. Finally, the ASEAN Plan of Action for Energy Cooperation (APAEC) serves as a strategic framework under the ASEAN umbrella, emphasizing energy connectivity and market

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[203] Williams, Brock R. *Trans-Pacific Partnership (TPP) Countries: Comparative Trade and Economic Analysis*.
[204] Bonafé, Ernesto. 2014. *Enhancing the Rule of Law in the Middle East and North Africa: A Role for the Energy Charter Treaty*. 1st Edition. Routledge.
[205] Villarreal, M. Angeles, and Ian F. Fergusson. 2017. "The North American Free Trade Agreement (NAFTA)." Congressional Research Service Report. May 24, 2017.

integration across Southeast Asia, akin to some of the ECT's goals[206]. These instances highlight how the ECT's features have been influential, with its principles being adapted and adopted within different regional frameworks. This not only underscores the treaty's significance in international energy governance but also marks its success in shaping global energy policy and cooperation.

VI. Discussion

The success of multilateral treaties in regulating innovative technologies is a complex and multifaceted issue that hinges on their adaptability, collaborative coordination, and transparency. These crucial elements demonstrated through specific features incorporated into treaty frameworks, are essential for addressing the dynamic challenges posed by technological advancements. My thesis provides a detailed analysis of how distinct features within multilateral treaties enhance their regulatory capabilities. Through case studies on railroads, telegraphs, electricity, and nuclear weapons, I illustrate that features such as amendment provisions, periodic reviews, trigger mechanisms, and knowledge sharing are integral to the success of these treaties.

In exploring the regulatory challenges and successes linked to emerging technologies across four case studies—railroads, telegraphs, nuclear weapons, and electricity—a pattern emerges, revealing that features such as amendment provisions, periodic reviews, trigger mechanisms, and knowledge sharing are seen as essential to the effectiveness of these treaties, but with varying levels of success. By reviewing evidence across these historical contexts, the

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[206] Chia, Siow Yue. 2014. "Chapter 10: The ASEAN Economic Community: Progress, Challenges, and Prospects." In *Economics 2014*, 269–315. DOI: 10.4337/9781783479283.00017.

outcome levels and associated explanations for each hypothesis are presented in the table below for quick reading.

Case Studies	**Hypothesis 1 - Periodic Review/Amendment mechanisms**	**Hypothesis 2 - Knowledge Sharing**	**Hypothesis 3 - Trigger Mechanisms**	**Success Outcome**
Railroads	High	High	High	High Success
Telegraph	High	High	Medium	Moderate Success
Nuclear Weapons	High	Low	Medium	Moderate Success
Electricity	High	Medium	High	Moderate Success

In examining Hypothesis 1, the effectiveness of periodic reviews and adjustments across the four case studies was significant. For the railroad industry, periodic review conferences held every five years, along with regular updates, allowed for continual improvements in safety, market stability, and technological advancements. This regulatory framework ensured that international railway transport adapted to evolving technologies and market fluctuations. By involving all stakeholders and centralizing the regulatory oversight through the Central Office for International Railway Transport, these reviews enabled comprehensive and coordinated responses to emerging challenges. In the telegraph industry, periodic reviews, which took place every few years, ensured that international standards kept pace with technological advances, operational needs, and evolving security requirements. For instance, review conferences adjusted technical guidelines, such as cable laying and message coding, which minimized service interruptions and enhanced data privacy. This adaptive strategy solidified international

cooperation, ensuring the continued reliability and security of telegraph services. In nuclear weapons regulation, both the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Treaty on the Prohibition of Nuclear Weapons (TPNW) incorporated periodic review mechanisms. These facilitated regular assessments of compliance, adaptations to technological changes, and negotiations amidst shifting political climates. The NPT review conferences, held every five years, assessed treaty implementation and allowed adjustments to prevent proliferation while also encouraging peaceful nuclear energy use. The TPNW followed a similar path by enabling continuous dialogue and treaty modification, emphasizing flexibility in the face of emerging global security challenges. Lastly, the Energy Charter Treaty (ECT) was designed to remain pertinent in the rapidly changing technological and market landscapes of electricity. Through structured amendment processes, including periodic review conferences and Article 42, the treaty ensured responsiveness to shifts in international trade, environmental standards, and energy supply chains. This mechanism allowed the treaty to adapt to modern energy needs by incorporating new environmental considerations and market integrations.

For Hypothesis 2, comprehensive knowledge sharing yielded mixed outcomes across the four case studies. In the railroad case, comprehensive databases and the Central Office for International Railway Transport facilitated rapid exchanges of scientific and technical data. Legal information and best practices were disseminated efficiently across borders, promoting the safe and streamlined operation of international railway systems. This knowledge-sharing approach was integral in standardizing procedures and technologies across nations. Similarly, the telegraph industry saw high success due to a centralized knowledge-sharing mechanism that bolstered international cooperation. These information exchanges enhanced telegraph network

reliability and provided a unified response to emerging technical and operational challenges. By establishing a global consensus on data transmission protocols, privacy guidelines, and service quality, nations were able to ensure consistent and secure telecommunication services.

Conversely, the nuclear weapons case exhibited low success in this regard. Moderate knowledge-sharing systems existed but were significantly underutilized. Exchanges of technical, environmental, and political data occurred infrequently due to geopolitical tensions and divergent national interests. Additionally, legal information was scattered, resulting in a fragmented regulatory landscape that impeded unified non-proliferation efforts. In the electricity case, the ECT facilitated knowledge sharing that influenced regional agreements, but it only achieved medium success due to geopolitical challenges and inconsistent implementation. While Article 19 of the treaty emphasized environmental protection and cooperation in technological innovation, challenges persisted in ensuring equitable distribution of knowledge due to varying national capacities. Data exchanges were inconsistent, and compliance across countries varied due to disparate levels of commitment.

In exploring Hypothesis 3, the success of trigger mechanisms also varied among the case studies. In the railroad industry, a high level of success was achieved due to well-defined trigger mechanisms. Immediate responses to operational challenges and market fluctuations were enabled through these triggers, preventing disruptions and maintaining high standards of safety and efficiency. By allowing for swift and decisive action, these mechanisms facilitated continuous improvements in the rail industry. For the telegraph industry, trigger mechanisms were only moderately successful. Although certain triggers existed to respond to specific challenges like network disruptions and protocol breaches, their activation was often delayed due

to unclear criteria or political interference. The mechanisms lacked precision and timely response, making international coordination less efficient. In the nuclear weapons domain, trigger mechanisms also achieved medium success. The NPT and TPNW included provisions for managing crises and preventing treaty breaches. However, their activation was often hindered by geopolitical tensions and varied national interests, which delayed timely interventions. Despite this, these mechanisms did provide pathways for addressing violations, encouraging dialogue and compliance. Finally, the electricity case, governed by the ECT, demonstrated high success with its trigger mechanisms. Articles 30 and 34 provided pathways for amendments and swift responses to specific events or criteria, enabling the Energy Charter Conference to react quickly to emerging challenges. The treaty's design allowed it to adapt to new technological, environmental, and market developments, maintaining its efficacy and relevance amid the dynamic energy sector.

In analyzing the four case studies through the lens of the three hypotheses, each case demonstrated particular strengths in the regulatory framework applied to emerging technologies. Although all cases correlated to some extent with the success parameters outlined in the hypotheses, their degrees of alignment varied due to specific historical and geopolitical factors. The railroad case exemplified strong correlation with Hypothesis 1 and Hypothesis 3. Its regulatory framework thrived on periodic reviews that allowed amendments and adjustments every five years, aligning perfectly with Hypothesis 1's principles. This mechanism helped address new challenges, ensuring that the railroad network remained efficient, safe, and responsive to technological changes. Furthermore, the well-defined trigger mechanisms enabled immediate responses to operational and market challenges, maintaining uninterrupted transport

services. For instance, the Central Office for International Railway Transport facilitated rapid dissemination of information and guidelines, preventing major disruptions. The periodic reviews and trigger mechanisms played a crucial role in establishing a cohesive framework that maintained high safety and technological standards, meeting regulatory challenges head-on.

In the telegraph case, strengths were particularly notable under Hypothesis 2, focusing on knowledge-sharing mechanisms. By establishing a centralized body for data exchange, the regulatory framework promoted international cooperation, which enhanced the reliability and security of telegraph services. Technical guidelines, standardized protocols, and privacy policies were shared among signatories, aligning global telegraph networks. However, the telegraph case was moderately successful in satisfying Hypothesis 3, where some trigger mechanisms were in place but activation was delayed by unclear criteria and political challenges. Despite this, the framework provided enough adaptability to allow periodic updates in line with technological changes.

The nuclear weapons case showcased notable strengths under Hypothesis 1, where the NPT and TPNW included periodic review mechanisms. These facilitated regular assessments and treaty modifications to prevent proliferation and adapt to new political climates. The emphasis on regular review allowed the treaties to address shifting security and technological issues effectively. However, knowledge-sharing mechanisms remained a challenge, achieving low success under Hypothesis 2. Although technical, political, and environmental data exchanges were intended to enhance compliance, geopolitical tensions, and scattered legal information hampered what could have been more efficient knowledge sharing. The geopolitical tensions often obstructed seamless knowledge dissemination, exacerbated by the fragmentation of legal

information across various platforms and jurisdictions. This fragmentation hindered the efficient sharing of crucial insights and best practices, impeding the collective efforts toward nuclear disarmament and non-proliferation. In terms of trigger mechanisms, the nuclear weapons case presented a mixed picture. While these mechanisms demonstrated a moderate level of success, their efficacy was occasionally hindered by conflicting national interests. Despite the potential for timely interventions to mitigate proliferation risks, divergent agendas among participating nations sometimes delayed or diluted the response, underscoring the complexities inherent in navigating geopolitical dynamics within the realm of nuclear security.

Lastly, the electricity case achieved notable success across all three hypotheses, though with varying degrees. The Energy Charter Treaty stood out by providing a structured amendment process (Hypothesis 1), ensuring relevance amid changing technological, environmental, and market landscapes. Article 42 facilitated amendments and periodic reviews, keeping the treaty responsive to international challenges. Knowledge-sharing mechanisms (Hypothesis 2) saw moderate success, with Article 19 emphasizing environmental protection and promoting best practices despite uneven implementation and geopolitical disparities. Trigger mechanisms (Hypothesis 3) proved highly effective through Articles 30 and 34, providing swift pathways for adjustments to emerging issues and ensuring that the treaty remained adaptable in a dynamic energy sector.

Moreover, the case studies examined in this thesis highlight the importance of achieving active and ongoing dialogue among parties to create more effective outcomes. Such coordination is essential not only for addressing immediate regulatory challenges but also for laying the groundwork for future cooperative efforts in response to new technological developments.

However, this research also recognizes the limitations and challenges inherent in treaty design. The variability in how different nations perceive and define success, coupled with the rapid pace of technological change, poses significant hurdles to creating universally effective regulatory frameworks. Furthermore, the diversity of technological impacts across different sectors and societies necessitates a tailored approach to treaty provisions, making standardization difficult.

Overall, while individual case studies highlighted strengths within particular hypotheses, collectively, they illustrated how periodic reviews, knowledge-sharing systems, and trigger mechanisms played integral roles in achieving regulatory success. Analyzing both strengths and limitations across these case studies offers valuable perspectives for developing resilient frameworks for managing the complexities of emerging technologies. The findings from my case studies not only validate the theoretical framework but also offer significant insights for shaping future treaties. This ensures that forthcoming agreements are well-prepared to tackle the evolving challenges presented by emerging technologies.

VII. Conclusion

As we stand at the height of an era increasingly defined by technological advances, the lessons drawn from historical multilateral treaties on technology regulation remain profoundly relevant. This thesis's findings underscore the essential elements that contribute to the success of such treaties, particularly adaptability, collaborative coordination, and transparency. These features are not merely beneficial; they are necessary to ensure that international agreements can evolve and respond to the dynamic nature of technology and global politics.

The ability to craft well-designed treaties plays a critical role in promoting better outcomes. A well-constructed treaty provides the flexibility needed to adapt to continual technological evolution, ensuring that regulatory frameworks can keep pace with innovation. This adaptability is crucial, especially in fields like artificial intelligence, where the applications and implications are vast and varied—from plagiarism detection to autonomous driving and complex decision-making algorithms.

However, policymakers still face significant challenges in regulating emerging technologies like AI. The rapid pace of technological innovation, often referred to as the "pacing problem," presents a major challenge. This issue arises when the speed of technological advancement outstrips the regulatory response, leading to outdated or irrelevant policies. Furthermore, the expansive nature of AI definitions can encompass a broad range of applications, leading to debates and confusion over the scope of regulation. These complexities require a nuanced approach to creating regulatory frameworks that are both flexible and precise enough to be effective. The inclusion of periodic reviews, amendment provisions, and trigger mechanisms, as identified in the case studies of railroads, telegraphs, and nuclear weapons, provides a blueprint for success and can be used as a starting point for policymakers. These mechanisms in the treaties have been linked to dynamically adjusting to accommodate new developments and challenges, thereby remaining effective over time.

Furthermore, as technology continues to dissolve the barriers between nations, promoting a fair distribution of technological benefits and responsibilities will be crucial. Knowledge sharing, as highlighted in this thesis, should be a cornerstone of future treaties, ensuring that all nations, regardless of their technological capabilities, can participate in and benefit from global innovations.

In conclusion, this thesis not only contributes to our understanding of treaty effectiveness in the context of technology regulation but also sets a forward-looking agenda for future international collaboration. By learning from the past and anticipating future challenges, we can hope to forge international agreements that harness the power of innovation while safeguarding human welfare and promoting global equity. As we continue to navigate this complex technology landscape, the insights from this thesis can guide the creation of more resilient, equitable, and effective regulatory frameworks.

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