EVALUATING GOVERNANCE AND THE ROLE OF INTERNATIONAL LAW IN PROTECTING NATURAL RESOURCES: SPACE POWERS AND THE MOON AGREEMENT

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Abstract

The renewed interest in lunar exploration has prompted a critical re-examination of the international legal framework governing the use of outer space resources. This article explores the role of international law, particularly the Moon Agreement, in regulating access to and protection of lunar resources, such as Helium-3. While existing treaties like the Outer Space Treaty provide foundational principles, they fall short in addressing the emerging realities of space mining and commercial exploitation. The study adopts a qualitative legal methodology, drawing from treaty analysis, state practice, and scholarly literature to assess the extent to which international law can accommodate technological advances and national interests. It argues that the lack of broad ratification of the Moon Agreement reflects a deeper uncertainty about the balance between common heritage principles and national ambitions. The findings suggest the need for a more cohesive and enforceable governance model capable of promoting sustainable and cooperative resource use. This article contributes to ongoing debates on space law by highlighting gaps in current frameworks and suggesting pathways for reform.

Keywords: Helium-3, Lunar Resource Governance, Space Mining, International Space Law, Sustainability, Legal Frameworks, International Cooperation

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1. INTRODUCTION

This research focuses on a multidisciplinary approach that combines legal perspectives from property, environmental, space, and resource management law. Through a systematic literature review, it explores the complexities of lunar resource governance, assessing the effectiveness of existing legal frameworks and regulatory landscapes. The analysis draws from the experiences of various spacefaring nations and presents real-world examples of how lunar resources are currently managed under diverse legal regimes.

A key focus of this study is the legal landscape surrounding Helium-3 mining on the Moon, an area gaining renewed attention in legal scholarship (Jakhu et al., 2021; Von Der Dunk, 2023). The paper adopts a blended legal framework that draws from multiple disciplines to demonstrate the difficulty of creating a unified legal structure for space mining.

Different governments and international bodies hold varied positions on the issue, making consensus and coordinated regulation a complex challenge.

The aim is to identify best practices and areas for improvement by examining different legal approaches (Von Der Dunk, 2023). This study seeks to contribute to the global discussion on establishing fair and effective legal systems that encourage international cooperation while ensuring responsible and sustainable exploitation of lunar resources. Helium-3, in particular, presents promising potential for clean energy and plays a key role in future space missions due to its abundance on the Moon (Jakhu & Pelton, 2017).

At the same time, significant legal and ethical concerns must be addressed. These include questions about ownership rights, environmental protections, and equitable access to lunar resources. National case studies offer practical insights into both the progress and limitations of current legal models. By evaluating these examples, the study assesses the applicability of its conceptual framework in managing the legal risks of lunar mining. Comparative analysis and interdisciplinary methods provide a solid foundation for understanding the challenges of regulating space resource use.

The findings support the call for a clearer and more consistent legal framework that can ensure sustainable development in space without compromising the interests of future generations. Addressing uncertainties in property rights and gaps in current treaties will be critical in moving forward with lunar mining activities, especially regarding Helium-3.

The rest of this paper is structured as follows. Section 2 reviews key literature and the theoretical underpinnings of lunar resource law. Section 3 outlines the methodology used in this study. Section 4 presents the results of a comparative analysis of national legal models and case studies. Section 5 discusses the legal challenges and implications of Helium-3 mining. Section 6 highlights the legal framework. Section 7 concludes with final reflections and suggestions for future research.

2. LITERATURE REVIEW

The governance of lunar resources has become a focal point of legal scholarship in light of renewed interest in space exploration and commercial space activities. Foundational instruments such as the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 1967 (Outer Space Treaty) and Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979 (Moon Agreement) establish broad principles of non-appropriation, peaceful use, and benefit-sharing. However, these instruments fall short of offering detailed regulatory mechanisms for resource extraction, particularly in the context of commercially driven missions (Jakhu et al., 2021; Von Der Dunk, 2023).

Recent legal scholarship has addressed this regulatory gap by exploring the intersection of space law, sustainability, and geopolitical interests. Abbas (2022) critically analyzes the economic and administrative dimensions of outer space governance and advocates for clearer institutional responsibility, especially in addressing emerging challenges like debris management and commercial exploitation. In a more recent study, Abbas (2024) highlights the evolving dynamics of commercial spaceflight and the legal uncertainties surrounding private-sector involvement, arguing for comprehensive reforms grounded in international cooperation and environmental stewardship.

The issue of Helium-3 mining on the Moon has received particular attention due to its potential value as a clean energy source and its implications for international legal norms. Scholars such as Byers and Boley (2023) and Durkee (2023) warn that current legal regimes are inadequate to address the growing competition over lunar resources and could lead to fragmented governance. Their work underscores the urgency of global legal coordination, particularly in light of rising national legislation such as the U.S. Commercial Space Launch Competitiveness Act of 2015 and Luxembourg's Law of 20 July 2017 on the exploration and use of space resources (Von Der Dunk, 2023; Byers & Boley, 2023).

Conceptually, the debate around lunar resource governance increasingly draws on the principle of the common heritage of mankind and the need for a more enforceable and inclusive legal regime. Daniel and Abbas (2024) explore the legal implications of space colonization and argue for sustainability-focused frameworks that balance innovation with legal responsibility. Their findings support the development of an institutional mechanism to ensure fair access and prevent monopolization. Similarly, Hassan and Sheer (2024) address the intersection of cybersecurity and space law, proposing collaborative legal models that account for digital infrastructure, transparency, and data protection in future lunar operations.

Sustainability and equitable resource management also feature prominently in recent literature. Scholars such as Moore et al. (2022) and Sawik (2023) emphasize the importance of integrating environmental law and resource governance principles into space law. De Zwart et al. (2023), Von Der Dunk (2023), and Elvis et al. (2021) propose conceptual frameworks that include environmental safeguards, protected zones on the lunar surface, and fair distribution mechanisms. These interdisciplinary approaches support a shift from purely aspirational legal texts to actionable, policy-driven governance.

In addition, comparative studies provide insight into national approaches and legal experimentation. For example, the United States promotes private-sector engagement and legal clarity through national legislation, while China adopts a more state-controlled approach centered on strategic objectives and long-term lunar infrastructure (Byers & Boley, 2023). Luxembourg's framework, by contrast, emphasizes public-private partnerships and legal certainty for investors. These examples, when analyzed comparatively, reveal diverging legal philosophies and underline the need for harmonization through international law.

Overall, the literature shows consensus on the need for stronger legal instruments, institutional oversight, and cooperative mechanisms to govern lunar resource activities. However, there remains divergence on how these mechanisms should be implemented and enforced. This research contributes to the debate by offering a multidisciplinary legal framework and a comparative analysis of national legal models, grounded in recent academic contributions, including those by Abbas (2022),

intending to promote a fair, transparent, and sustainable approach to Helium-3 mining and lunar resource governance.

3. RESEARCH METHODOLOGY

This study employs a qualitative doctrinal methodology, focusing on the interpretation and analysis of legal instruments, academic literature, and policy documents relevant to lunar resource governance and Helium-3 mining. The research is rooted in a legal analytical framework, which allows for a detailed examination of both international and national legal texts, with particular attention to the principles of space law, environmental protection, property rights, and sustainable resource use.

The data for this study is drawn entirely from secondary sources, including key international treaties such as the Outer Space Treaty (1967) and the Moon Agreement (1979), as well as United Nations General Assembly resolutions and other legally relevant instruments. In addition, scholarly articles, legal commentaries, space agency publications, and reports from international organizations were thoroughly reviewed. These sources were selected based on their academic credibility, relevance to the subject matter, and significance in shaping current debates on space law and lunar resource regulation.

The research followed a thematic analysis approach, identifying and organizing recurring legal issues such as ownership rights, regulatory fragmentation, sustainability, and equitable access. These themes served as the foundation for a structured legal discussion, helping to highlight both the strengths and limitations of the existing international legal framework.

A comparative legal analysis was also conducted to examine how different jurisdictions, particularly the United States, Luxembourg, and China, approach space resource governance. This comparative element provides insight into evolving national practices and potential legal models that could inform broader international consensus.

To frame this analysis, a multidisciplinary conceptual framework was developed, combining elements of international law, environmental law, and resource management theory. This framework supports a more holistic understanding of the legal, ethical, and policy implications of Helium-3 mining.

While the study does not incorporate empirical methods such as interviews or fieldwork, these were not necessary given the nature of the research questions. The doctrinal approach is sufficient to provide a rigorous legal evaluation and to propose potential pathways for reform within the existing legal system.

It is acknowledged that the rapidly evolving nature of space activities and the limited ratification of certain treaties present challenges in generalizing findings. Nonetheless, the methodology applied offers a solid foundation for assessing legal gaps and for advancing recommendations on the governance of lunar resources in a responsible, cooperative, and sustainable manner.

4. RESULTS AND DISCUSSION

The findings of this research highlight the critical need for a comprehensive and enforceable legal framework to govern the mining and appropriation of Helium-3 on the Moon. Although the foundational principles laid out in the Outer Space Treaty (1967) and the Moon Agreement (1979) provide essential guidance, they are no longer adequate in the face of evolving commercial interests, technological advancements, and national ambitions. The current international legal framework lacks the clarity, enforcement mechanisms, and consensus necessary to regulate lunar mining sustainably and equitably.

The comparative analysis of national approaches reveals a diverse and often conflicting set of legal strategies. The United States has taken a market-oriented stance by allowing private entities to extract and own space resources, as reflected in the U.S. Commercial Space Launch Competitiveness Act (United States Congress, 2015) and the Artemis Accords. Luxembourg has adopted a similar approach, promoting legal certainty for investors through specific national legislation. In contrast, China has maintained a state-led model, with space exploration activities managed centrally and framed within long-term national planning. These differing legal philosophies demonstrate the absence of a unified global vision, and they risk furthering legal fragmentation and competition rather than cooperation.

The findings also reinforce the importance of embedding environmental and ethical considerations into lunar governance. Unregulated exploitation of Helium-3 could lead to ecological harm and reinforce global inequalities if a few powerful states or corporations dominate access. As this study has shown, a multidisciplinary conceptual framework, combining international law, environmental law, property rights, and sustainable resource management, is essential to navigate these challenges. Such a framework encourages environmental protection through precautionary measures, promotes fair benefit-sharing among nations, and supports inclusive decision-making.

Importantly, this study emphasizes the need for an internationally coordinated legal structure, one that not only regulates resource extraction but also ensures accountability, transparency, and dispute resolution. The role of international institutions, such as the United Nations Office for Outer Space Affairs (UNOOSA), must be strengthened to oversee compliance, facilitate dialogue among spacefaring and developing nations, and uphold the principle that outer space, including the Moon, is the common heritage of all humankind.

In conclusion, while national initiatives are advancing quickly, the lack of a unified and enforceable global legal framework remains a fundamental obstacle. Without collaborative governance, the future of space resource extraction may mirror the inequalities and environmental degradation experienced in terrestrial contexts. It is therefore imperative that international legal reform moves in tandem with scientific progress to ensure that the benefits of lunar mining, especially of resources like Helium-3, are shared responsibly and equitably.

5. OBSTACLES AND CHALLENGES

5.1. Lack of a specific legal framework for lunar resource exploitation

Another key legal difficulty is the lack of a particular legal framework governing the mining of lunar resources such as Helium-3. While international

space law establishes fundamental concepts and rules for space operations, it does not give precise restrictions adapted to the specific circumstances of lunar mining (Von Der Dunk, 2023). The lack of a particular legal framework calls into question who is responsible for regulating mining activities and guaranteeing fair access to lunar resources. Is it necessary for an international agency to regulate and coordinate lunar resource extraction, or should mining activities be overseen entirely by the laws of individual space-faring nations? Furthermore, how can states ensure that moon resources are used to benefit all of humanity while avoiding monopolistic practices?

To stimulate international collaboration and responsible resource management, a comprehensive legal framework that tackles the difficulties of lunar resource utilization is required (Abbas, 2022). To ensure the long-term viability of Helium-3 mining on the Moon, such a framework should address environmental preservation, sustainable resource utilization, and fair benefit sharing (Elvis et al., 2021). As a result, the legal difficulties and constraints of Helium-3 mining on the Moon center around uncertainties in property rights and ownership, ambiguities in international space law, and the lack of a specialized legal framework for lunar resource exploitation. Addressing these issues is critical for realizing the potential advantages of Helium-3 as a clean and plentiful energy source, as well as guaranteeing the equitable and responsible exploration of the Moon's resources for the benefit of all humanity.

5.2. Multidisciplinary conceptual framework for lunar resource governance

This framework tries to provide a complete strategy that addresses not only the technical elements of lunar resource extraction but also the ethical and environmental components by incorporating ideas from international law, environmental law, property rights, and resource management. International space law controls the exploration and use of outer space, including the Moon, and establishes the guiding legal principles for space operations. The necessity of preserving celestial bodies, particularly the Moon, from damaging human activities is emphasized in environmental law (Von Der Dunk, 2023). Our understanding of the biosphere of the moon is limited, thus, it limits our understanding of the potential impact of mining on the fragile environment of the moon. Considering natural integrity, complete environmental impact assessments (EIAs) are vital before mining activities (de Zwart et al., 2023). The framework highlights that developing protected areas and buffer zones on the moon might safeguard prospective habitats. The policies must maintain consistency with global environmental law and ethical extraction of resources.

5.3. Ensuring sustainable resource management

An important part of the conceptual framework features sustainable resource management (SRM). It recognizes that lunar resources, such as Helium-3, are considered to be scarce. For this reason, this resource is required to be used in a sustainable manner. SRM framework promotes the incorporation of substantial resource extraction practices of in-situ resource utilization (ISRU) and recycling methodologies. This framework is accompanied by to increase in the lifespan of lunar resources for future generations. It aims to minimize waste and maximize the efficiency of the resources.

Furthermore, SRM encourages the need for international partnership and information interchange among the space-faring nations. It is considered a fundamental framework that minimizes overexploitation. In addition, this framework enhances the collective resource management initiatives (de Zwart et al., 2023). To improve openness and accountability, the construction of a worldwide lunar resource register in which governments acknowledge their mining operations and resource utilization is proposed.

5.4. Ensuring equitable access to lunar resources

In the conceptual framework, equitable access to lunar resources is a key premise. Under international space law, the Moon is considered the common legacy of all humanity, and the framework strives to protect this idea (de Zwart et al., 2023). It argues for procedures that assure the equitable sharing of gains obtained from lunar resource exploitation among all states, particularly underdeveloped ones. To accomplish this, the framework recommends the creation of an international structure, similar to a resource-sharing agreement, in which states pool their resources and skills to perform collaborative lunar mining initiatives. It also encourages underdeveloped nations to participate in space mining operations through capacity-building programs and technology transfer efforts.

5.5. Potential implications and effectiveness of the conceptual framework

When applied to space mining operations, the interdisciplinary conceptual framework can define ethical and sustainable resource extraction practices (Moore et al., 2022). The framework portrays the foundation for international partnership in lunar resource governance. It is capable of taking into account optimal environmental preservation, sustainable resource management, and equitable access.

However, it is acknowledged that issues in the implementation of this framework are expected to emerge. It includes acquiring the consensus among the space-faring governments. It occurred due to their diversified mindsets and agendas. The international space law pictures a voluntary character (de Zwart et al., 2023). Barriers to the enforcement of the conceptual framework can occur due to the possibility of non-compliance.

To improve the efficiency of the framework, it is vital to gain support from the major stakeholders and the international community. This incorporates the varied space agencies, industry actions, and non-governmental organizations. With better communication channels and collaboration, the framework is targeted to improve. These tactics are fundamental for building the adaptability of the framework in the changing technological dimension and geopolitical realities.

As a result, it is analyzed that the interdisciplinary conceptual framework for lunar resource governance is substantial. It aims to deliver a probable road forward in dealing with the legal

challenges of Helium-3 mining on the lunar surface. It is fundamental to providing a responsible and sustainable way of resource extraction in the space mining sector. It integrates both international law and environmental law principles. The framework demonstrates the importance of environmental protection and the promotion of the SRM. It further makes sure that the regions can gain equitable access to lunar resources (Elvis et al., 2021). Nonetheless, it is essential to acknowledge that the effective execution of the framework is dominated by international collaboration. Regions are required to showcase a shared responsibility and commitment to conserving the ecosystems of the Moon. It is a significant component needed to ensure the benefit of all humanity.

5.6. Comparative analysis of international approaches to space mining

Different regions around the globe point to a varied concept of governance regarding space mining activities. The international organization also demonstrates a diverse trajectory of interests and legal framework regarding this attribute. Conducting an in-depth comparative analysis is crucial for understanding the ability of various nations to manage space mining and resource appropriation. This discussion aims to explore the degree of transparency and cooperation visualized in the governance of lunar resource extraction among different countries. It aims to analyze their differences in the legal framework for space mining activities. Also, an evaluation is needed to understand the dynamic approach of countries that are still in the process of formulating policies for lunar resources (Von Der Dunk, 2023). The target of this subsection is to emphasize identifying the best practices and potential areas of improvement for space mining activities.

5.7. Transparency and cooperation in lunar resource governance

Transparency and collaboration are critical components of efficient lunar resource exploitation governance. Transparency in a country's legal structure and regulations on space mining is critical for developing international collaboration and averting possible problems. Open and transparent policies aid in the development of trust among spacefaring nations and promote collaborative efforts to explore and use lunar resources.

Countries that have created legal frameworks for space mining, such as the United States, have shown a comparatively high level of openness in their regulations. The Commercial Space Launch Competitiveness Act, passed in 2015, establishes a firm legal foundation for private businesses to claim ownership of resources gained from celestial bodies (Alemanno, 2022). This legislation clarifies the rights and duties of private corporations and other space-faring states in the utilization of lunar resources.

Countries that are still developing regulations for space mining, on the other hand, may encounter difficulties in establishing a comparable degree of transparency. Uncertainties concerning resource rights and ownership might arise in the lack of clear legislation, thereby impeding international collaboration. As these nations' legal systems evolve, the adoption of open and comprehensive regulations will be critical in encouraging collaboration and supporting responsible resource exploitation.

5.8. Best practices in international cooperation

Because space mining activities have global repercussions and possible advantages for all humanity, effective international collaboration is critical for the regulation of lunar resource exploitation. Countries that are known to have optimal legal frameworks for space mining can portray an enhanced level of international cooperation among the space-faring states.

In 2020, the United States established the Artemis Accords to encourage international cooperation in lunar exploration and resource utilization. It is regarded as an important step in fortifying the complexities of lunar activities. The principles incorporated in this Accord visualize the guidelines for lunar exploration and the extraction of resources. This includes the peaceful usage of the lunar and space resources. It also aims to guide the exchange of scientific data among the member states (Deplano, 2021). Countries are working towards developing a considerable spirit of cooperation and coordination in their space mining efforts by showing alignment with the Artemis Accords. Furthermore, the European Space Agency (ESA) has engaged in ensuring cooperation and collaboration among its member countries. It has curated different events for refining cooperative reinforcement in lunar exploration. It urges the member states to combine their knowledge base to generate mutual benefit.

6. LEGAL FRAMEWORKS

6.1. Uncertainties surrounding property rights and ownership

Ambiguities in ownership rights of lunar resources are one of the biggest uncertainties to be solved. The principle of "humankind's common heritage" poses a dilemma in determining whether the lunar resources can be privately held or not. As per the Outer Space Treaty (1967), lunar resources are not subject to national appropriation. Thus, it does not tolerate ownership of such resources and opposes claiming lunar resources, particularly Helium-3. In recent years, countries and business entities have been interested in asserting property rights on lunar resources. For example, in 2015, the Commercial Space Launch Competitiveness Act of the United States allowed businesses to claim ownership of extracting resources from celestial bodies. Debate remains on the validity of state legislation.

6.2. Ambiguities in international space law

The Moon Agreement of 1984 wants to combat resource exploitation and prioritize the principle of "common heritage of mankind". However, countries like Russia, the United States, and China are not signatories to this (Droege, 2014). As a result, the Moon Agreement lacks general acceptability and fails to establish a complete framework for lunar resource control (Deplano, 2021; Von Der Dunk, 2023). The ambiguities in international space law underline the importance of additional

conversations and coordinated efforts among space-faring governments to develop clear and binding norms for lunar resource exploitation. Recent frameworks like the Artemis Accords offer a potential basis for cooperation, but they have also raised concerns about exclusion and fragmentation in global space governance (Durkee, 2023). Without a coordinated strategy, there is a risk of conflicts and competing claims over Helium-3 mining rights on the Moon, which might stymie sustainable and ethical resource utilization.

6.3. Case studies of space-faring nations

This section of the paper is going to examine the case studies of the country's activity involved in space exploration procedures. It also aims to explore the countries spearheading future Helium-3 mining initiatives. It is crucial to analyze their experiences, regulations, and difficulties in the management of space mining activities. This section is going to draw significant lessons for the creation of prominent legal frameworks in the management of lunar resource exploration. Reviewing real-world instances of triumphs and challenges is the major direction of this section to highlight the important areas of alignment. In addition, the investigation of national legislation and international collaboration in establishing the legal environment of space mining is needed to generate reform (Von Der Dunk, 2023).

6.4. United States: A pioneer in space mining regulations

The case study of the United States explores the significance of the Commercial Space Launch Competitiveness Act in asserting the dynamics of commercial space mining firms. The debate is going to pay attention to the difficulties of these firms in obtaining and exercising the space law. It also features the role played by the government in supervising the mechanism of responsible resource exploitation (Byers & Boley, 2023).

6.5. Luxembourg: Embracing public-private partnerships in space mining

The Luxembourg government has pursued the potential for space mining with a vital legal framework. It works towards encouraging public collaboration in this industry. The 2017 “Law on the Exploration and Use of Space Resources" has been vocal in picturing the commercial enterprise to get licenses for space mining activities. It also boosts collaboration with the government and the private organization. This case study is influential in understanding the features of the regulatory framework. It transcribes the region’s growth in the space mining sector. The conversation is going to evaluate the efficiency of public-private partnerships in improving lunar resource extraction. In addition, it is going to define the role of the government in encouraging private investment.

6.6. China: A growing contender in lunar resource exploration

The region has made considerable advances in space exploration. It has made big promises in the management of lunar space exploration, including the extraction of Helium-3. “Chang’e missions” are developed by this region to portray successful landings on the Moon. The government has plans to build a permanent lunar base for resource exploitation. This region features a different approach to space mining from that of the US and Luxembourg (Byers & Boley, 2023). The Chinese case study showcases the region’s approach to space mining. It will transition to legal structures that regulate lunar resource exploitation. The debate is vital in picturing the region’s collaboration with foreign partners. This Asian region is attempting to engage in a responsible manner for the sustainable usage of lunar resources.

6.7. International cooperation and multilateral initiatives

There are varied international collaborations embedded in creating a legal environment for space mining. The “Moon Agreement of 1979" is a notable global endeavor focused on lunar resource control. This agreement states that the Moon and its resources are considered to be the "common heritage of mankind.” In addition, the agreement calls for global cooperation in the exploration and utilization of lunar resources.

It defines the execution and difficulties projected in gaining international border consensus. It is going to look at different ways to improve international collaboration in lunar resource exploration. It explains the role of the Artemis Accords and UNOOSA (Byers & Boley, 2023).

The case studies of the space-faring states provide significant insights into the legal complications of Helium-3 mining. The above-highlighted experiences of the United States, Luxembourg, and China showcase a variety of methods of space mining. Each of these cases demonstrates its own set of obstacles and potential. It is seen that the legal framework and public-private partnership play an important role in the promotion of responsible resource utilization. It fosters an adequate level of private investment in lunar resource management. Moreover, the case studies have focused on the need for international collaboration and multilateral actions in defining lunar resource extraction governance (Byers & Boley, 2023). With this knowledge base, policymakers are going to acquire knowledge on creating effective and fair legal systems for future space mining.

6.8. Space law scholars: Perspectives on regulatory frameworks

Analysis carried out by space law experts has features insight into the challenges in building a regulatory framework for lunar resource exploration (Jakhu & Pelton, 2017). Experts have stressed the significance of establishing the proper rights of lunar rights to avoid future disputes (Durkee, 2023). It gives significant importance to international collaboration in developing a unified strategy for space mining. The law scholars aim to ensure that all governments have equal access to lunar resources. In addition, scholars need to take environmental protection and sustainable resource management into account for developing a prominent legal framework.

6.9. Legal practitioners: Challenges in navigating the legal landscape

Space law practitioners have highlighted their experiences in navigating the growing legal landscape of space mining. Their evaluation has described the difficulties in implementing the current international space law concepts for the mining of lunar resources. Proper navigation is needed to resolve the gaps present in the legal framework. A significant emphasis is needed for creating special legislation geared to space mining activities (United Nations General Assembly, 2022). Also, the legal professionals defined the need for public-private collaborations in progressing space mining initiatives. They have been facing difficulties in finding the right balance between economic interests and global advantages.

6.10. Space agency representatives: Coordinating international efforts

The space agency representatives have shared a prominent insight into the worldwide coordination of space exploration. This ideology reflects on the concepts of lunar resource utilization operations as well. The agency representatives have stated that the current cooperation is working towards the promotion of ethical and sustainable resource exploitation on the Moon. The study visualized the difficulties faced in aligning national interests and building confidence among space-faring states. The analysis acquired from the space agency representation explains the need for open communication channels for sharing information. It also plays an essential role in the formation of effective alliances.

6.11. Resource management and environmental experts: Sustainability and responsible use

The necessity of the sustainable usage of lunar resources is aligned with proper resource management. The environmental specialties are vital in featuring careful usage of this lunar directive. It is mainly focused on approaches for measuring the environmental effects of space mining activities. It is also targeted to define sustainable risk-mitigation strategies. These experts have acknowledged the need for long-term resource management strategies. They have considered the long-term sustainability measures to avoid resource depletion.

6.12. Bridging the gap: Integration of expert insights

The data acquired from this analysis has highlighted the common themes and areas of agreement among the opinions of the experts. In this section of the paper, the prospective ideas for tackling the legal constraints and problems of Helium-3 mining on the Moon will be discussed.

As a result, the findings garnered from this study provide different insights into the legal challenges of lunar resource exploration. The perspectives gained from different experts have idealized a comprehensive knowledge of the practical execution of legal frameworks in controlling space mining operations. With the usage of clear, precise regulations, space mining activities are intended to be regulated. It is going to solve the particular issues embedded in the lunar resource management. It further ensures responsible and sustainable resource utilization (Ellery, 2022). Policymakers are going to benefit from incorporating expert perspectives in the creation of better legal directives. It is essential to develop a community that works towards designing an equitable regulatory framework for Helium-3 mining on the Moon.

6.13. Ethical implications of space mining

Critical examination of the ethical implications of space mining on the Moon is vital. It is targeted to define the ethical issues surrounding the extraction of Helium-3 and other lunar resources. It is also going to discuss the possible influence on the lunar environment with these mining activities.

The ethical implications regarding responsible resource management and avoidance of hazardous actions are highly critical. The issues generated by such damages are subject to causing disturbance to the Moon's delicate biosphere. These are some important aspects aimed to be investigated in this section of the paper.

One of the key ethical problems in the management of lunar resource extraction is the issue of ecological disruption (Elvis et al., 2021). The lunar ecosystem is recognized to be unique. The practitioner needs to pressure the lunar surface for future generations to retain scientific and educational relevance. For this reason, any mining activities must adhere to sustainable development standards. It is vital to avoid any form of irrevocable alteration to the Moon's natural terrain.

Another ethical issue is embedded in the equal distribution of the rewards and opportunities associated with lunar mining. The data regarding the Helium-3 mining needs to be resurfaced to the viable communities for future research. It is essential to share the economic and technological benefits linked with the usage of lunar space mining among the different nations. International cooperation is required to make sure that the space mining benefits are transferred to the whole global community. It should not exacerbate the current imbalances. Moreover, the ethical implications concerning the possibility of disputes over lunar resources need to be examined. With the growth of lunar exploration and resource utilization, issues are subject to emerge. There is a potential for territorial conflicts to form between space-faring states (de Zwart et al., 2023). The international legal system needs to include provisions for dispute settlement. With the creation of peaceful collaborations, the legal system is going to minimize future wars.

6.14. International cooperation and sustainable practices

To minimize these ethical concerns, the study is going to picture international collaboration in lunar resource control. Optimal collaboration between the space-faring nations is much needed for the establishment of responsible space-mining practices. The creation of an international agency is vital in monitoring the lunar resource governance. It works towards encouraging equitable benefit sharing and transparency.

The use of a multidisciplinary conceptual framework in this governance system includes best-

in-class ideas from international laws. It also includes guidelines from the environmental law and property rights for the development of sustainable space mining practices. Overall, this framework is going to provide a balanced approach to protecting the environment of the Moon. It is also going to allow responsible usage of its resources by integrating legal concepts with environmental concerns.

7. CONCLUSION

This study examined the legal and policy challenges surrounding lunar resource governance, with a focus on Helium-3 mining and the adequacy of existing international legal frameworks. The findings emphasize the urgent need for enforceable, coordinated legal mechanisms that reflect current technological capabilities and geopolitical realities.

Regarding implications of the findings, the results highlight the growing disconnect between aspirational legal principles, such as the "common heritage of mankind", and national-level legislative developments promoting commercial exploitation. Without a cohesive legal framework, lunar mining risks reproducing the same inequalities and environmental issues found on Earth. A more harmonized legal regime would support international cooperation, foster investor confidence, and ensure the equitable distribution of benefits among nations. The limitations of the research study primarily used doctrinal and comparative methods, relying on treaty texts, scholarly analysis, and case studies. It does not include empirical fieldwork or interviews with policymakers and private sector actors. Moreover, the limited ratification of key treaties, particularly the Moon Agreement, restricts the applicability of some of the legal concepts explored.

Future studies could benefit from empirical investigations into national implementation practices, the role of private actors, and how spacefaring and developing nations interpret and apply space law. There is also a need to examine the socio-economic and environmental impact of Helium-3 mining in greater depth. Further research should explore frameworks for dispute resolution, equitable access, and long-term monitoring of lunar activities. Overall, the study contributes to the evolving discourse on sustainable space governance and offers a conceptual foundation for future legal reforms that promote both innovation and global responsibility in space exploration.

REFERENCES

Abbas, S. (2022, July 16–24). *A panacea to address the legal, administrative and economic aspects of space debris* (Paper presentation). The 44th COSPAR Scientific Assembly. COSPAR. https://ui.adsabs.harvard.edu/abs/2022cosp...44.3433A/abstract

Abbas, S. (2024). Apprehensions with regard to commercial space flight: Outlook on space law. *Journal of Astronomy and Space Sciences, 41*(4), 235–247. https://doi.org/10.5140/JASS.2024.41.4.235

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, adopted December 5, 1979, opened for signature December 18, 1979, entered into force July 11, 1984, 1363 U.N.T.S. 3. United Nations Treaty Collection. https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXIV-2&chapter=24&clang=_en

Alemanno, F. (2022). *Latest results from the DAMPE space mission* (Paper presentation). The 2022 VHEPU session of the 56th Rencontres de Moriond. Cornell University. https://doi.org/10.48550/arXiv.2209.06014

Byers, M., & Boley, A. (2023). *Who owns outer space? International law, astrophysics, and the sustainable development of space*. Cambridge University Press. https://doi.org/10.1017/9781108597135

Daniel, S. S., & Abbas, S. (2024). Legal implications of the space colonization and the UAE's sustainable approach towards Mars Mission. *Journal of East Asia and International Law, 17*(1), 129–146. https://doi.org/10.14330/jeail.2024.17.1.07

de Zwart, M., Henderson, S., & Neumann, M. (2023). Space resource activities and the evolution of international space law. *Acta Astronautica, 211*, 155–162. https://doi.org/10.1016/j.actaastro.2023.06.009

Deplano, R. (2021). The Artemis Accords: Evolution or revolution in international space law. *International & Comparative Law Quarterly, 70*(3), 799–819. https://doi.org/10.1017/S0020589321000142

Droege, P. (2014). *100% Renewable: Energy autonomy in action*. Routledge.

Durkee, M. J. (2023). Space law as twenty-first century international law. *Journal of Law & Innovation, 6*(1), Article 6. https://doi.org/10.58112/jli.6-1.2

Ellery, A. (2022). Leveraging in situ resources for lunar base construction. *Canadian Journal of Civil Engineering, 49*(5), 657–674. https://doi.org/10.1139/cjce-2021-0098

Elvis, M., Krolikowski, A., & Milligan, T. (2021). Concentrated lunar resources: Imminent implications for governance and justice. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 379*(2188), Article 20190563. https://doi.org/10.1098/rsta.2019.0563

Government of Luxembourg. (2017). Law of 20 July 2017 on the exploration and use of space resources. *Official Journal of the Grand of Duchy of Luxembourg*. https://legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo

Hasin, G. (2020). Developing a global order for space resources: A regime evolution approach. *Georgetown International Law Journal, 52,* 77–159. https://www.law.georgetown.edu/international-law-journal/wp-content/uploads/sites/21/2021/03/DEVELOPING-A-GLOBAL-ORDER-FOR-SPACE-RESOURCES-A-REGIME-EVOLUTION-APPROACH.pdf

Hassan, A., & Sheer, A. (2024). Cybersecurity challenges in outer space: Innovation, Collaboration and Legal Reforms. *Journal of East Asia and International Law, 17*(2), 405–422. https://scispace.com/pdf/cybersecurity-challenges-in-outer-space-innovation-2cqxma3xmrfg.pdf

Jakhu, R., & Pelton, J. N. (2017). *Global space governance: An international study*. Springer. https://doi.org/10.1007/978-3-319-54364-2

Moore, K. R., Segura-Salazar, J., Bridges, L., Diallo, P., Doyle, K., Johnson, C., Foster, P., Pollard, N., Whyte, N., & Wright, O. (2022). The out-of-this-world hype cycle: Progression towards sustainable terrestrial resource production. *Resources, Conservation and Recycling, 186*, Article 106519. https://doi.org/10.1016/j.resconrec.2022.106519

Sawik, B. (2023). Space mission risk, sustainability and supply chain: Review, multi-objective optimization model and practical approach. *Sustainability, 15*(14), Article 11002. https://doi.org/10.3390/su151411002

Sheer, A., & Li, S. (2019). Space debris: A new Broadway to address organizational and operational aspects for removal. *Journal of East Asia & International Law, 12*(2), 269–282. https://doi.org/10.14330/jeail.2019.12.2.02

Storr, C. (2021). "Space is the only way to go": The evolution of the extractivist imaginary of international law. In S. Chalmers & S. Pahuja (Eds.), *Routledge handbook of international law and the humanities*. Routledge. https://doi.org/10.4324/9781003170914-27

Tetik, B. (2023). *The outer space as a domain of competition and cooperation from the Cold War to today* [Master thesis, Middle East Technical University]. Middle East Technical University. https://open.metu.edu.tr/handle/11511/105342

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, opened for signature January 27, 1967, entered into force October 10, 1967, 610 U.N.T.S. 205. https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html

United Nations General Assembly. (2022). *Resolution adopted by the General Assembly on 12 December 2022* (A/RES/77/123). United Nations. https://undocs.org/en/A/RES/77/123

United States Congress. (2015). *U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704*. https://www.congress.gov/114/plaws/publ90/PLAW-114publ90.pdf

Von Der Dunk, F. (2023). Property rights over the Moon or on the Moon? The legality of space resource exploitation on celestial bodies. *Journal of Law & Innovation, 6*(1), 95–133. https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1028&context=jli