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Space Mining Laws and Regulations: A Comparative Analysis of International Treaties and National Legislation

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Abstract:

With the advancement of technology and growing interest among governmental and private entities, space mining has shifted from the realm of science fiction to a real prospect. The main goal of this paper is to explore the legal systems regarding the space mining business. It analyses the various working and living legal structure confines and restrictions of current international and national laws and ethical issues related with space resources. Accordingly, this research seeks to assess whether the present legal instruments are sufficient and efficient enough in dealing with the multifaceted issues surrounding space mining.

Additionally, the paper aims to draw conclusions regarding the capacity of current laws to adequately govern the exploitation of space resources and suggest measures to enhance the formulation of proper legislation on the matter. This framework should aim at balancing the rights of the users for the rational and fair use of space resources and the obligations to preserve the outer space environment and the general public's concern.

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The study uses a qualitative methodology that includes textual analysis. Findings point to the urgent need for comprehensive international laws that address sustainability and fair resource distribution. The paper ends with suggestions for potential legal frameworks that could protect the interests of all parties involved in space mining.

Keywords: space mining, regulations, legal framework, Outer Space Treaty, Moon Treaty, international law, sovereignty, resource extraction, property rights, environmental impact, ethics, commercial interests, national legislation, mining licenses.

I. Introduction:

Both scientific curiosity and the potential for financial gain have fueled the rise of interest in space mining over the past ten years (Cortázar & Cordero,2023). Asteroids, the Moon, and even planets like Mars could one day be used to extract valuable resources (Krolikowsi&Milligan,2022). Thanks to technological advancements, this is becoming less of a science fiction fantasy and more of a realistic possibility. The lure is strong: the Moon holds Helium-3 that could revolutionize nuclear energy, asteroids may hold vast reserves of valuable metals like platinum and gold, and Mars holds the promise of an entirely new planet to explore and possibly colonize. This uncharted territory does, however, present important legal issues that have not yet been fully resolved. The 1967 Outer Space Treaty, the founding agreement governing space activities, forbids national appropriation of celestial bodies, but it is unclear how resources can be taken from these bodies (Ishola & Taiwo 2021). It creates a legal void that could give rise to disagreements, exploitation, and potentially harmful "space races" between states and commercial enterprises. For instance, the U.S. Commercial Space Launch Competitiveness Act of 2015 permits Americans to "possess, own, transport, and sell" resources taken from celestial bodies, which may conflict with international law, which regards space and celestial bodies as the "province of all mankind"(Schwartz 2020).

Additionally, the few legal laws that do exist are primarily Earth-centric and poorly suited to address the particular difficulties that space mining presents. These Cold War-era laws occasionally conflict with more recent national laws intended to encourage investment in commercial space activities. For example, Luxembourg's Space Resources Law of 2017 permits Luxembourg entities to own space resources, which is similar to

the U.S. law and raises concerns about the legality of such a move under international law (Guyomar'h,2023).

Foremost among the difficulties that hinder the migration of mental health professionals to rural areas are the legal problems. It is essential to consider problems like how mining activities can impact the environment, how resources need to be shared ethically, and ultimately what are the moral consequences of increasing financial benefits from celestial bodies. This moral issue is no longer a theoretical issue; indeed, it has pragmatic repercussions for how humanity can build the right guardrails and regulations in the use of space (Guyomar'h,2023). The misdemeanors shown here overshadow the fact that modern laws either are too old-fashioned or are not intensifying enough to face the troubles of space exploitation. And there is an immediate necessity for all countries to sit down and agree on an accurate set of international rules as the development of technology moves forward and we get closer to the stage when mining in space is feasible (Schwartz 2020). More importantly, these laws should not only clarify the details of the existing laws but should also provide guidelines that will ensure that this new frontier is neither abused nor monopolized and is used in the best way possible to benefit all humankind and not a small group of honorable rulers.

I. 1Research Objectives:

Three main objectives this study will be centered on are highlighted below. Basically, it aims at clarifying the complex existing legal frameworks that are in place and delineating space mining regulation through international agreements and national laws. The second aims at the investigation of the moral implications of extraterrestrial resource use.

This includes, but is not confined to, concern about the just distribution of advantage and the sustainability of the surroundings. The next part of the paper is the recommendation of creating new legal frameworks aimed at filling gaps and bringing clarity into the ambiguous provisions of the current law. Through this, it tends to give a bit of contribution to the young but very quickly growing field of space law by suggesting the right options to the ones who are decision makers, i.e. academics and industries.

I.2: Problems and questions of study

The legal frameworks that control space exploration and exploitation were largely developed as a result of the Moon Agreement of 1979 and the Outer Space Treaty of 1967(Nelson, 2020). These documents have set the stage for the regulation of mining operations in space, a topic that has grown complicated and contentious.

On the Outer Space Treaty, which has been ratified by more than 100 countries, international space law is based (Kestenko,2020). The Moon and other planets are specifically excluded from "national appropriation by claim of sovereignty, by means of use or occupation, or by any other means" according to Article II of the treaty. In other words, no nation has the right to claim a celestial body as its own. However, the treaty makes no mention of using these celestial bodies' resources for human benefit. It is not stated explicitly whether a nation or private organization is permitted to mine an asteroid, for instance, and then claim ownership of the resources obtained.

This ambiguity has given rise to numerous interpretations and discussions in the legal community and the larger international community. While the Outer Space Treaty forbids national appropriation of celestial

bodies, some legal experts contend that it does not forbid resource exploitation (Shri,2021). Others claim that the exploitation of resources equates to appropriation, which goes against the letter, if not the spirit, of the treaty. The Moon Agreement of 1979 was established to fill this legal gap (Hobe,2019). By suggesting that the Moon and its resources are the "common heritage of mankind" and urging the establishment of an "international regime" to regulate mining operations, it went one step further than the Outer Space Treaty. However, none of the major space-faring countries, including the United States, Russia, and China, have ratified the Moon Agreement. As a result, it lacks the power to establish a framework for space mining regulation that is widely accepted. Individual nations have acted to enact laws in this area because there is no comprehensive international legal framework. The U.S. Commercial Space Launch Competitiveness Act, which was passed in 2015, expressly permits American citizens to "engage in the commercial exploration for and recovery of space resources"(Feichtner,2019). Similar to Luxembourg, which allowed businesses registered there to own any resources they mine in space, Luxembourg enacted its Space Resources Law in 2017. These national laws raise a number of questions even though their goal is to encourage investment in space mining (Svetlichnyj,2019). First, there is the issue of whether the Outer Space Treaty is violated by these laws. Would mining an asteroid by a company with a U.S. or Luxembourg base, for instance, violate the treaty's ban on national appropriation? Second, these regulations may result in a "first-come, first-served" situation in which nations compete for mining territory in space, akin to the "Scramble for Africa" of the colonial era but on a cosmic scale. Conflicts and the heedless exploitation of space resources are both possible outcomes of such a scenario.

These national frameworks also don't cover more extensive ethical and environmental issues. What measures will be taken to protect celestial bodies from ecological deterioration? How will the advantages of space mining be fairly divided among countries, particularly those who lack the technological capacity to mine space resources? While the Moon Agreement and the Outer Space Treaty have provided a fundamental framework for space law, they are woefully insufficient to regulate the newly emerging industry of space mining (Xu & Mehdi,2020). National laws, such as those of the United States and Luxembourg, are attempts to fill this void, but they primarily raise more questions than they address, particularly with regard to their legality under international law and their moral ramifications. A strong international legal framework that not only fills in the gaps but also addresses the ethical implications of extraterrestrial resource exploitation is urgently needed in light of the emergence of space mining activities. Failure to do so could result in legal disputes and moral conundrums that could harm future space exploration (Black & Martin,2022).

I.3: Methodology of study

This Paper aims to contribute to this burgeoning field of study dissecting the existing legal frameworks, pinpointing their limitations, and introducing ethical considerations that should inform future laws and international agreements (Heino,2021) as the frontier of space becomes increasingly accessible, it is crucial that the scholarly debates translate into actionable policies to navigate the ethical and legal complexities of space mining effectively.

The secondary qualitative methodology used in this study to investigate the moral and legal frameworks governing space mining (Ruggiano&

perry,2019). A qualitative approach is thought to be the most suitable for capturing the nuances and intricacies of legal principles, ethical considerations, and policy implications given the complex and dynamic nature of the subject (Cheron&Colomby,2022).

II. Legal Frameworks:

These national frameworks also don't cover more extensive ethical and environmental issues. What measures will be taken to protect celestial bodies from ecological deterioration? How will the advantages of space mining be fairly divided among countries, particularly those who lack the technological capacity to mine space resources? While the Moon Agreement and the Outer Space Treaty have provided a fundamental framework for space law, they are woefully insufficient to regulate the newly emerging industry of space mining (Xu & Mehdi,2020). National laws, such as those of the United States and Luxembourg, are attempts to fill this void, but they primarily raise more questions than they address, particularly with regard to their legality under international law and their moral ramifications. A strong international legal framework that not only fills in the gaps but also addresses the ethical implications of extraterrestrial resource exploitation is urgently needed in light of emergence of space mining activated. Failure to do so could result in legal disputes and moral conundrums that could harm future space exploration (Black & Martin,2022)

II.1: Current Scholarly Debates:

The burgeoning interest in space mining has ignited a flurry of debates among legal scholars, ethicists, and policymakers. With the rapid advancements in space technology, the prospect of harvesting celestial resources is no longer confined to the pages of science fiction but is a

tangible reality that humanity must soon confront (Švec,2022). This makes the gaps and ambiguities in international space law even bigger, which makes it a hot topic for academic debates.

The concept of ownership rights in space is the most debated topic. At the core of the issue is a notion of the "common heritage of mankind", which was envisioned in the Moon Agreement (Black & Martin,2022). The main principle is that the celestial bodies and their resources belong to the whole of humanity, and that their use is meant to benefit all mankind (Pershing, 2019). However, the absence of an agreed international framework, which would specify how this principle would take into account space mining activities, makes the situation uncertain as yet. Some scholars are of the opinion that nation-states and even private organizations don't have any right to claim these celestial bodies in full ownership as well. In their view, this action would violate the spirit of "common heritage" principle which alleges that all countries should give equal rewards for their contribution to such treasures.

Here the line of reasoning is that the potential investors in space exploration will not tolerate any sharing of the profits id they don't get full ownership or exclusive rights to the benefits. Concerning national laws, the necessity of having a set of universal rules emerges e.g. the Commercial Space Launch Competitiveness Act of 2015 of U.S.A or the Space Resources Law of 2017 of Luxumbourg. These laws provide ownership of the outer space resources to the companies as well as individuals of different countries due to differences in their laws as well as when a country's company may claim to the same resources as another company. (De Cnudde, 2019; Rummel et al. , 2021). These laws represent a fundamental challenge to the' common heritage' principle and are often cited in scholarly debates as examples of

dissonance between national interests and international principles (Svec& Schmidt,2022).

Beyond legal technicalities, the discussion has also expanded into the realm of ethics. Central to ethical debates are issues of sustainability and environmental impact. With Earth already grappling with the consequences of unsustainable mining practices, scholars argue that humanity must exercise extreme caution to avoid replicating these destructive behaviors in space (Antwi & Owusu,2022). There is a growing awareness that ethicists and environmental scientists are an important part of this disclosure, and they are proponents of strict rules that give priority to the preservation of the environment. In addition, the issue of fair sharing of benefits is another ethical aspect which is becoming more and more popular. The potential value locked within celestial bodies could be astronomical (Henio,2021). If only a few technologically advanced countries or corporations gain control over these resources, the economic disparity between nations could widen. Scholars are thus questioning how to establish a framework that ensures the just distribution of benefits. Adding another layer of complexity are geopolitical considerations. The race for space resources has the potential to trigger international conflicts and challenge existing notions of sovereignty (Rabitz,2023). Therefore, scholars are examining models of international cooperation that could serve as a blueprint for collective action in space exploration and resource extraction. Given this intricate tapestry of legal intricacies, ethical dilemmas and geopolitical concerns, there is an urgent need for comprehensive, interdisciplinary research to guide future policy and legislation.

II.2: International Legal Framework

The Outer Space Treaty of 1967 was the most significant of the frameworks of international law that came into being during the Cold War to govern space activities. The treaty defines the basic principles of space law, including the ban on national appropriation of celestial bodies and the requirement for space to be used only for peaceful purposes. Regarding mining and resource extraction from celestial bodies, the treaty is ambiguous (Rivaldi,2019). Even though it prohibits national appropriation, it does not specifically address whether or how entities may claim the resources they extract. This ambiguity has led to a variety of interpretations as space mining becomes a reality, which poses a challenge for the global community.

The Moon Agreement of 1979 proposed a "international regime" to control the use of the Moon's resources in an effort to fill some of these gaps (Malysheva&Huroya,2021). Its impact has been limited as a result of the absence of ratification by significant spacefaring nations like the United States, Russia, and China. The treaty has not received widespread acceptance as a result, making it useless as a practical manual for ongoing space mining operations (Hofmann&Bergamasco,2020).

The Outer Space Treaty of 1967 is the most important piece of international law. This agreement is important because it was one of the first attempts to create a legal framework for extraterrestrial activities (Ishola&Taiwo,2021). It also makes it clear that celestial bodies cannot be used for "national appropriation." But it brings up a lot of questions, especially about mining in space. The treaty creates a legal gray area because it doesn't say whether or not it is legal to take resources from celestial bodies. This has led to a lot of discussion among legal experts.

For example, does the ban on "national appropriation" include the use of resources that have been mined, or does it only apply to claiming the land around celestial bodies?

The Moon Agreement of 1979 is another important international agreement that goes a step further by saying that celestial bodies and their resources should be seen as the "common heritage of mankind." But since important space-faring countries like the United States, Russia, and China haven't signed it, it can't be used or enforced and isn't as good as it could be. The agreement also calls for the creation of an "international regime" to control how resources are used. However, because this clause hasn't been widely adopted, it is still mostly just an idea (Phady&Phady,2021).

II.3: National Legal Framework

Lacking comprehensive international regulations, individual nations have taken the initiative to create their own legal frameworks for space mining. A major turning point in history was the Commercial Space Launch Competitiveness Act of 2015, which allowed Americans to freely own and trade resources obtained from celestial bodies. In 2017, Luxembourg introduced its Space Resources Law, which grants comparable ownership rights to organizations registered in Luxembourg(Pekkanen,2019). However, these national laws produce a legal paradox: even though they adhere to domestic legal norms, they might go against the guidelines set forth in the Outer Space Treaty, particularly the ban on national appropriation.

On a national level, laws like Luxembourg's Space Resources Law of 2017 and the U.S. Commercial Space Launch Competitiveness Act of 2015 are crucial. These laws stand out because they are one-off attempts to fill the gaps left by international treaties in the law (Deplano,2021).

They implicitly undermine the notion of "common heritage" by granting citizens and entities the right to own the resources they extract from space. As a result, there could be a conflict between national and international legal systems, which raises concerns about which legal system should take precedence and whether they can coexist.

II.4: Comparative Analysis:

A contrast of national space law makes it evident that space mining is approached from different sides. While the transaction size of nations like the United States and Luxembourg has enlarged, others play the waiting game and wait for common consent. The divergence from the norm indicates an unsustainable legal system that only necessitates disagreement and conflict. What would be the situation if two businesses from different countries were involved in the case of the ownership of one asteroid? In such cases, they can be the root cause of many legal obstacles in the absence of a unified legal system, thus aggravating the hard-to-solve problem of mining in space further. The existing legal frameworks, be it international or national, cannot be entirely applied and they are inadequate to create legal frameworks for tackling the new problems space mining brings. The international law's ambiguity and each country acting separately without comprehensive international guidelines contribute to the current regulatory gap; thus, immediate attention should be given to fill it. A brand-new all-encompassing system of jurisprudence which will be able to take care of the national interests in the context of the international obligations and morality and is required urgently given the high stakes engaged.

III. Ethical and Social Implications:

III.1: Sustainability

The search for cosmic resources gives rise to serious questions about environmental sustainability. Asteroids and the Moon lack ecosystems, in contrast to Earth, but the processes used to mine these bodies could still have long-lasting and possibly irreversible effects. For instance, the extraction techniques might cause contamination by releasing volatile substances. The Moon Agreement of 1979 proposed that resources in space be regarded as a "common heritage of mankind," raising the ethical question of whether humanity has the right to exploit them (Prasad,2019). In order to ensure that space exploration serves the long-term interests of humanity, the concept of sustainability goes beyond environmental concerns to include intergenerational equity (Vashkevich&Timashova,2021).

III.2: Inclusivity

The issue of inclusivity and equitable access to space resources is another crucial ethical factor. The current economic landscape, which is dominated by a small number of advanced economies, runs the risk of resulting in a "space divide," where only a select few countries are able to take advantage of the enormous potential that space mining offers. The global social and economic disparities that already exist could be made worse by this concentration of resources and advantages. Because of this, any legal framework governing space mining must address the equitable distribution of benefits and guarantee that all nations, regardless of their technological or economic prowess, have access to space.

III.3: Wealth Distribution and Power Dynamics

Power dynamics and wealth distribution are closely related to inclusivity. The money made from mining in space could be enormous—possibly trillions of dollars (Landers,2023). Who has the authority to determine how this wealth is divided? Should these dangerous missions only be carried out by private companies, or should there be a system for more equitable distribution, especially to nations without the resources to engage in space mining? Legal frameworks must address ethical concerns in order to prevent monopolistic practices and guarantee fair competition. The potential for a small number of entities to amass enormous wealth and power from space resources.

Space mining's legal frameworks are inextricably linked to its ethical and social ramifications (Kwiecień,2022). The resolution of these issues involves not only the law but also morality and social justice. These ethical considerations must be incorporated into the legal frameworks that will control our actions beyond Earth as we stand at the dawn of a new era in space exploration (Massaro&Bhattacharya,2023). Failure to do so could lead to legal disputes as well as moral conundrums that could harm future space exploration.

IIII. Case Studies:

IIII.1: Asteroid Mining:

Due to the potential abundance of valuable resources like platinum, gold, and rare earth elements, asteroid mining has drawn a lot of attention (Shreya,2022). The legal issues involved with asteroid mining are complicated, though. Companies like Planetary Resources and Deep Space

Industries have expressed interest in mining asteroids, but their endeavors are in danger due to the lack of a clear international regulatory framework (Hein&Fries,2020). For instance, the U.S. Commercial Space Launch Competitiveness Act of 2015 would allow a U.S.-based company to claim ownership of the resources if it mined an asteroid. The Outer Space Treaty, which forbids national appropriation of celestial bodies, might prevent this, though. The ethical aspects are equally complex, posing issues such as who "owns" the resources in reality and how rewards ought to be distributed (Hobe&Aguilar,2021).

IIII.2: Lunar Mining:

The Moon is another excellent candidate for mining, particularly for materials like helium 3, which is plentiful on the lunar surface but rare on Earth (Svensson&Persson,2022). The potential for helium-3 to revolutionize energy production makes lunar mining an appealing business. However, there are numerous legal issues. The Moon Agreement declares the Moon and its resources to be the "common heritage of mankind," but significant nations like the United States, Russia, and China have not ratified the agreement. The U.S.-initiated Artemis Accords offer a framework for lunar activities, but there isn't universal agreement on them (Gillbert,2023). There are also ethical issues to take into account, such as whether mining operations should be permitted in locations deemed to be of "cultural importance," such as the Apollo mission landing sites.

The difficulties and ambiguities present in the current legal frameworks governing space mining are illustrated by both case studies. The absence of precise, widely accepted rules creates a tumultuous environment that is conducive to legal disputes and moral conundrums, whether it concerns

asteroids or the Moon (Massanz,2020). These case studies serve as sobering reminders, highlighting the pressing need for thorough international regulations that can address the moral and legal issues raised by the developing industry of space mining.

IIII.3: Mars Mining:

Discussions about the moral and legal ramifications of resource extraction on the Red Planet have been sparked by the appeal of Mars as the next frontier for human exploration and potential colonization (Thangavelauthan&Jensen,2019). While its geological formations and the potential for subsurface water ice—essential for both supporting human life and for the synthesis of fuel—excite the scientific community, the legal framework for mining on Mars is, at best, unclear. The primary international treaty governing celestial bodies, the Outer Space Treaty of 1967, expressly forbids national appropriation but is less clear on resource utilization. This ambiguity invites a range of interpretations. One of the most important queries is whether a habitat built on Mars might be able to assert rights to nearby resources based on "use"(Volger et al.,2020). A claim like that might go against the fundamental tenet of the treaty, which is that celestial bodies are the "province of all mankind." The complexity is increased further by ethical considerations. Planetary protection or making sure that human activities on Mars do not contaminate it in a way that would impede future scientific research or, more importantly, harm any potential ecosystems that may exist, however minute they may be, is one of the main issues. Any native Martian ecosystems, if they exist or ever did, could suffer irreparable consequences from the "forward contamination" of Mars by Earth organisms. Furthermore, discussions frequently veer into the realm of hypothetical ethics: What if upcoming missions find evidence

of past or present life on Mars? Then, would mining operations be regarded as an encroachment or even a desecration of a celestial body that contains or has contained life? Such moral impasses collide with legal ambiguities, creating a complex web of unanswered issues that upend our preconceived notions in the case of Mars mining.

IIII.4: Mining on Jovian Moons:

Because of their alleged enormous reserves of water ice and possibly other valuable minerals, the Jovian moons Europa, Ganymede, and Callisto offer an intriguing prospect for space mining. The ethical and legal environment surrounding these endeavors, however, is complicated (Kostenko,2020). Although the Outer Space Treaty of 1967 offers a basic framework, its applicability becomes more difficult in light of the great distances to the Jovian system and the potential involvement of numerous states and private organizations. Implementation of the ruling and enforcement and, therefore, how it will be affected on the territorial boundaries begin to emerge as key questions. The issue here is not the prohibition of country claims, but the fact that the regulation of celestial bodies' resources is unclear. Moreover, when we talk about a really high level of international or even worldwide collaborations, these uncertainties are seen even more profoundly. Who will be managing the complication related to distribution of the resources? Which nation takes the leading role in regulating this and, secondly, who gets the benefits? Private entities also bring in a new complication into the matters at hand because they possibly work inside a national judiciary which may or may not apply international standards. In addition to all the other ethical problems where environmental and planetary protection is concerned, let me highlight another issue. For this reason, the classification of Europa, Ganymede, and Callisto as oceans

seems to hypothesize that life may exist within their subsurface fueling further scientific interest. Mining operations could incur contamination of the environment shaped by extraterrestrial living systems which might lead to an imbalance of the ecology and scientific endeavors directed towards the exploration of extraterrestrial life on these moons. Such life systems would probably show us that we are not alone in the universe which will increase ethical issues as life is found in any environment that might just contain microbes, even if they are not alive (Kostenko,2020)

IIII.5: Deep Space Waystations:

The assumption of remote cognizance outposts implies a new angle for the ethical and legal problems in the sphere of space and space utilization. Such responsibilities, which could include platforms or refueling systems at crucial locations like liberation points, are projected to be the foundations of future exploration. Notably, these might also provide a place where humans can reside. They hold enormous potential for facilitating prolonged missions and even permanent settlements in space as the cornerstones of an emerging space economy. Deep-space waystations pose a difficult problem from a legal perspective (Horton et al.,2019). The 1967 Outer Space Treaty, which forms the basis of international space law, forbids national appropriation of celestial bodies but says nothing about man-made space structures.

This raises issues of ownership and jurisdiction: Would these waystations be seen as outposts of the country that deployed them, or would they be subject to some sort of global jurisdiction? This is especially important when we take into account the possibility of these stations being used for business, which could result in significant financial gains. If a waystation

were to be regarded as a national asset, it might create a precedent for space-based territorial claims, which would go against the Outer Space Treaty's ideals of global cooperation (Deplano,2023). The construction of deep-space waystations raises ethical issues related to access and possible militarization. Do other countries have unrestricted access to a waystation's amenities if it falls under their jurisdiction? Could a country use its waystation for military operations or restrict access to it during tense political times? These issues aren't just hypothetical; they might have a big impact on diplomacy and international security.

V. Conclusions:

V.1: Results

In time, space mining may facilitate the discovery of new sources of materials that mankind has never possessed while at the same time it could be an insurmountable challenge to overcome. The colossal flow of economic development and progress in the fields of technology human skills and proficiency constitutes a fulfilment of such a potential only barely not touched yet. To secure the peacefulness of space mining performed in a manner that are reasonable, ethical, and defendable, the space chapter on law and ethics is quite complicated. Criticizing and imagining new approaches in creating the datasets to tackle the world problems such as data privacy, artificial intelligence (AI) ethics by this essay has joined the conversation.

Overall, it could be claimed that space regulators are not yet well-equipped to identify the activities that will take place beyond the Earth. We so urgently need new laws of good conduct, in which the national interests of the country are not the only priorities but also the other nations'

rights and the ethical stances of the nation. Establishing the ethical and legal system that will govern the use of these natural resources is crucial in view of the fact that we are not just passive users, and we are the ones that interfere in the exploration of outer space. Not doing so would make the whole business hostile and semi-profitable. Also, managers would misuse employees and the injustice in the process becomes an issue.

Upon reviewing these five case studies, several common themes emerge that highlight the complexities and challenges in regulating space mining: Upon reviewing these five case studies, several common themes emerge that highlight the complexities and challenges in regulating space mining:

1. Ambiguity in International Law: Every case study that has been continued to illuminate the loopholes and grey areas in the international treaty system like the Outer Space Treaty as well as mining operations of the moon and deep space.

2. National vs. International Interests: Often it is mining on the Moon, Mars, or asteroids that brings this dilemma into the spotlight. This difficulty occurs because national laws and international conventions are applied simultaneously if not properly coordinated. Countries including the United States and Luxembourg and like-minded countries, enacted laws and regulations that are possibly in conflict with globally accepted principles.

3. Ethical Concerns: The multiplicity of these cases diversifies the ethical problem solving, as it can be ecology, the potential harm of the alien ecosystems or fair sharing of resources. Sometimes legal regulations lag in answering the ethical issues that are considered very important.

4. Jurisdictional Challenges: A situation like this when extension to the Jovian moons and further off waystations is required, the complication of who is responsible for what and the power to enforce regulations becomes more and more difficult.

5. Technological Advances vs. Legal Stagnation: While technologies are making such mining scenarios easily achievable, the legal system with the institutions and bodies to enforce it is falling behind creating a different gap that needs urgent attention.

V.2: Recommendations and Proposals

Proposals for International Regulations:

Complexity of the prominent feature, multi-dimensionality and the space mining imperatives generate an ardent appeal towards intricate international regulation applicable to this venture. The drafter of a global legally binding treaty which clearly closes the gaps left not only by the Treaty on Outer Space but also by the Moon Agreement could be another solution. The responsibility of technological charges would be under the authority of the body, while the status of held responsible face of nature would be over the ecological demands. In light of this, a body that will be a mediator can work. It is only proper that such mediation can work through moral and legal norms binding all the parties.

Ethical Guidelines:

Mining in space cannot progress unless the environment is protected, and there must be no compromises on general human welfare. That is why morality, as well as statutory, systems need to be developed in this respect. Such laws have to address the following issues: intergenerational justice,

ecological wellbeing along with fairness in the total profit distribution. The development of an intellectual property regime that is varied and neat can be achieved by drawing on knowledge from the spheres of science, ethics, policy, as well as, the Third World characters.

References:

Antwi, B. O., Agyapong, D., & Owusu, D. (2022). Green supply chain practices and sustainable performance of mining firms: Evidence from a developing country. Cleaner Logistics and Supply Chain, 4, 100046. https://www.sciencedirect.com/science/article/pii/S2772390922000191 https://doi.org/10.1016/j.clscn.2022.100046

Black, J., Slapakova, L., & Martin, K. (2022). Future Uses of Space out to 2050. RAND Corporation. https://www.rand.org/content/dam/rand/pubs/research_reports/RRA600/RRA609-1/RAND_RRA609-2.annex.pdf

Cheron, C., Salvagni, J., & Colomby, R. K. (2022). The qualitative approach interview in administration: A guide for researchers. Revista de Administração Contemporânea, 26, e210011. https://www.scielo.br/j/rac/a/FNdhmJLJjTGLRGZ8qpxKtvf/ https://doi.org/10.1590/1982-7849rac2022210011.en

Cortázar, A., & Cordero, G. (2023). Evaluating the Space Mining. Revista Mexicana de Astronomıa y Astrofisica Serie de Conferencias (RMxAC), 55, 129-129. http://www.astroscu.unam.mx/rmaa/RMxAC..55/PDF/RMxAC..55_ACortazar-LXV.pdf

Deplano, R. (2021). The Artemis Accords: Evolution or revolution in international space law?. International & Comparative Law Quarterly, 70(3), 799-819. https://www.cambridge.org/core/journals/international-and-comparative-law-quarterly/article/artemis-accords-evolution-or-revolution-in-international-space-law/DC08E6D42F7D5A971067E6A1BA442DF1

Deplano, R. (2023). INCLUSIVE SPACE LAW: THE CONCEPT OF BENEFIT SHARING IN THE OUTER SPACE TREATY. International & Comparative Law Quarterly, 72(3), 671-714. https://www.cambridge.org/core/journals/international-and-comparative-law-quarterly/article/inclusive-space-law-the-concept-of-benefit-sharing-in-the-outer-space-treaty/C33312A56A05D8B38C96CB5E3DDD0F41 https://doi.org/10.1017/S0020589323000234

Feichtner, I. (2019). Mining for humanity in the deep sea and outer space: The role of small states and international law in the extraterritorial expansion of extraction. Leiden Journal of International Law, 32(2), 255-274. https://www.cambridge.org/core/journals/leiden-journal-of-international-law/article/mining-for-humanity-in-the-deep-sea-and-outer-space-the-role-of-small-states-and-international-law-in-the-extraterritorial-expansion-of-extraction/03DD7A15D7C82D5C2BAFAA7014698B6F https://doi.org/10.1017/S0922156519000013

Hannon, T. P. (2022). Outer Space Mining and the Future of Space Law (Doctoral dissertation, University of Nevada, Reno). https://www.proquest.com/openview/ebcb6116afd3ebdbff1017b84fcb9aee/1?pq-origsite=gscholar&cbl=18750&diss=y

Hein, A. M., Matheson, R., & Fries, D. (2020). A techno-economic analysis of asteroid mining. Acta Astronautica, 168, 104-115. https://www.sciencedirect.com/science/article/abs/pii/S0094576518316357 https://doi.org/10.1016/j.actaastro.2019.05.009

Heino, B. (2021). Space, Place and Capitalism: The Literary Geographies of The Unknown Industrial Prisoner. Springer Nature. https://link.springer.com/book/10.1007/978-981-16-4262-3 https://doi.org/10.1007/978-981-16-4262-3

Hobe, S. (2019). Space law. Nomos Verlag. https://books.google.co.in/books?hl=en&lr=&id=wKe5DwAAQBAJ&oi=fnd&pg=PP1&dq=+Moon+Agreement+of+1979+was+established+to+fill+this+legal+gap&ots=XxxGCc_yXH&sig=anXDFaQ72-evGYGJlIZIqoKRC5M&redir_esc=y#v=onepage&q&f=false

Hobe, S., Schmidt-Tedd, B., Schrogl, K. U., & Aguilar, R. M. (Eds.). (2021). Comentario de Colonia al Derecho del Espacio. Tratado del Espacio. Cologne Commentary on Space Law. Outer Space Treaty. Dykinson. https://books.google.co.in/books?hl=en&lr=&id=adx4EAAAQBAJ&oi=fnd&pg=PR16&dq=+Outer+Space+Treaty+on+celestial+bodies&ots=ZVEnM43NFh&sig=_wGd98Xz4QCN3WQzKVxkl7ZI2Ao&redir_esc=y#v=onepage&q=Outer%20Space%20Treaty%20on%20celestial%20bodies&f=false

Hofmann, M., & Bergamasco, F. (2020). Space resources activities from the perspective of sustainability: Legal aspects. Global sustainability, 3, e4. https://www.cambridge.org/core/journals/global-sustainability/article/space-resources-activities-from-the-perspective-of-sustainability-legal-aspects/DF153F4A77970AC9E12444EC2B001F8A https://doi.org/10.1017/sus.2019.27

Horton, J. F., Kokan, T., Joyner, C. R., Morris, D., & Noble, R. (2019, February). Lunar Landing And Sample Return From Near Rectilinear Halo Orbit Using High-Powered Solar Electric Propulsion. In 42nd AAS Annual Guidance and Control Conference, Breckenridge, Colorado. https://www.researchgate.net/profile/James-Horton-4/publication/332351293_Lunar_Landing_and_Sample_Return_from_Near_Rectilinear_Halo_Orbit_using_High-Powered_Solar_Electric_Propulsion/links/5d6823c1a6fdccadeae42b3a/Lunar-Landing-and-Sample-Return-from-Near-Rectilinear-Halo-Orbit-using-High-Powered-Solar-Electric-Propulsion.pdf

Ishola, F. R., Fadipe, O., & Taiwo, O. C. (2021). Legal Enforceability of International Space Laws: An Appraisal of 1967 Outer Space Treaty. New Space, 9(1), 33-37. https://www.liebertpub.com/doi/abs/10.1089/space.2020.0038 https://doi.org/10.1089/space.2020.0038

Ishola, F. R., Fadipe, O., & Taiwo, O. C. (2021). Legal Enforceability of International Space Laws: An Appraisal of 1967 Outer Space Treaty. New Space, 9(1), 33-37. https://www.liebertpub.com/doi/abs/10.1089/space.2020.0038 https://doi.org/10.1089/space.2020.0038

Kostenko, I. (2020). Current problems and challenges in international space law: Legal aspects. Advanced Space Law, 5(1), 48-57. http://asljournal.org/journals/2020-5/ASL_vol_5_Kostenko.pdf https://doi.org/10.29202/asl/2020/5/5

Kwiecień, R. (2022). The space resource mining activities and the problems of (in) completeness and (un) certainty of international space law: a critical overview of the main issues. Problemy Współczesnego Prawa Międzynarodowego, Europejskiego i Porównawczego, 20. https://ruj.uj.edu.pl/xmlui/handle/item/302398

Landers, A. (2023). The place of space mining news in the valuation of stocks. https://www.diva-portal.org/smash/record.jsf?dswid=-6109&pid=diva2%3A1763731

Malysheva, N., & Hurova, A. (2021). New Frontiers of Sustainable Human's Activities: Challenges for Legal Order of Space Mining Economy. Advanced Space Law, 8, 76-85. http://asljournal.org/journals/2022-8/ASL_vol_8_MalyshevaHurova.pdf https://doi.org/10.29202/asl/8/7

Mas Sanz, E. (2020). Origin and minearology of Lunar meteorites. A study for lunar mining and resources exploitation (Master's thesis, Universitat Politècnica de Catalunya). https://upcommons.upc.edu/handle/2117/330601

Massaro Tieze, S., Liddell, L. C., Santa Maria, S. R., & Bhattacharya, S. (2023). BioSentinel: a biological CubeSat for deep space exploration. Astrobiology, 23(6), 631-636. https://www.liebertpub.com/doi/full/10.1089/ast.2019.2068 https://doi.org/10.1089/ast.2019.2068

Muzyka, K. (2021). Paragraphs for Space Shoggoths, Bush robots, and Dyson Trees-the legal complexity of manufacturing space objects using natural and artificial space resources. Ad Astra. Program badań nad astropolityką i prawem kosmicznym, (2), 5-22. https://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_53261_adastra20210202

Nelson, J. W. (2020, December). The Artemis Accords and the future of international space law. In American Society of International Law (Vol. 24, No. 31). https://www.asil.org/sites/default/files/ASIL_Insights_2020_V24_I31.pdf

Padhy, A. K., & Padhy, A. K. (2021). Legal conundrums of space tourism. Acta Astronautica, 184, 269-273. https://www.sciencedirect.com/science/article/abs/pii/S0094576521001703 https://doi.org/10.1016/j.actaastro.2021.04.024

Pekkanen, S. M. (2019). Governing the new space race. American Journal of International Law, 113, 92-97. https://www.cambridge.org/core/journals/american-journal-of-international-law/article/governing-the-new-space-race/14BD9B37A7A15A8E225A5355BB29E51B https://doi.org/10.1017/aju.2019.16

Pershing, A. D. (2019). Interpreting the outer space treaty's non-appropriation principle: Customary international law from 1967 to today. Yale J. Int'l L., 44, 149. https://heinonline.org/HOL/LandingPage?handle=hein.journals/yjil44&div=8&id=&page=

Prasad, M. D. (2019). Relevance of the sustainable development concept for international space law: An analysis. Space Policy, 47, 166-174. https://www.sciencedirect.com/science/article/abs/pii/S0265964618300596 https://doi.org/10.1016/j.spacepol.2018.12.001

Rabitz, F. (2023). Space resources and the politics of international regime formation. International Journal of the commons, 17(1), 243-255. https://epubl.ktu.edu/object/elaba:174761362/ https://doi.org/10.5334/ijc.1274

Race, N. S. (2019). Sustainable space mining. Nature Astronomy, 3, 465. https://www.nature.com/articles/s41550-019-0827-7 https://doi.org/10.1038/s41550-019-0827-7

Rivaldi, R. (2022). THE ARTEMIS ACCORDS AND PROPERTY RIGHTS IN OUTER SPACE. Journal of Law and Policy Transformation, 7(2), 36-46. https://journal.uib.ac.id/index.php/jlpt/article/view/7236 https://doi.org/10.37253/jlpt.v7i2.7236

Ruggiano, N., & Perry, T. E. (2019). Conducting secondary analysis of qualitative data: Should we, can we, and how?. Qualitative Social Work, 18(1), 81-97. https://journals.sagepub.com/doi/full/10.1177/1473325017700701 https://doi.org/10.1177/1473325017700701

Schwartz, J. S. (2020). The value of science in space exploration. Oxford University Press. https://books.google.co.in/books?hl=en&lr=&id=3yTTDwAAQBAJ&oi=fnd&pg=PP1&dq=U.S.+Commercial+Space+Launch+Competitiveness+Act+of+2015&ots=dYTR58WOVq&sig=s2Cq2UMGdCQb3HKWWLcWp-zFVKA&redir_esc=y#v=onepage&q=U.S.%20Commercial%20Space%20Launch%20Competitiveness%20Act%20of%202015&f=false

Shreya Mane, A. (2022). Asteroid Mining: Opportunities and Challenges. Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal, 11(1), 13-16. https://eduzonejournal.com/index.php/eiprmj/article/view/22

Shri, A. (2021). Property Rights in Outer Space. INTERNATIONAL JOURNAL FOR LEGAL RESEARCH AND ANALYSIS. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4024327

Svec, M. (2022). Outer space, an area recognised as res communis omnium: limits of national space mining law. Space Policy, 60, 101473. https://www.sciencedirect.com/science/article/abs/pii/S0265964621000655 https://doi.org/10.1016/j.spacepol.2021.101473

Švec, M., Boháček, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to operate as an alternative source of both legality and legitimacy. Oil, Gas & Energy Law, 1. https://planetary-defense.eu/wp-content/uploads/2020/11/ov18-1-article17-notitle.pdf

Svensson, F., & Persson, K. (2022). A Concept Design to Enable Lunar Mining. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1664757&dswid=-6109

Svetlichnyj, O., & Levchenko, D. (2019). Commercialization of Space Activities: Correlation of Private and Public Interest in the Pursuit of Outer Space Exploration. Advanced Space Law, 4(1), 21-29. http://asljournal.org/journals/2019-4/ASL_vol_4_SvetlichnyjLevchenko.pdf https://doi.org/10.29202/asl/2019/4/8

Thangavelautham, J., Chandra, A., & Jensen, E. (2019). Autonomous Multirobot Technologies for Mars Mining Base Construction and Operation. arXiv preprint arXiv:1910.03829. https://arxiv.org/abs/1910.03829 https://doi.org/10.1109/AERO47225.2020.9172811

Tobiska, W. K. (2023). A strategic architecture for growing a space economy utilizing foundational space weather. arXiv preprint arXiv:2307.08776. https://arxiv.org/abs/2307.08776 https://doi.org/10.22541/essoar.168988467.79593783/v1

Vashkevich, V., & Timashova, V. (2021). From Philosophy of Cosmos to Space Policy: Contemporary Issues and Trends. Philosophy and Cosmology, 26, 35-45. https://www.ceeol.com/search/article-detail?id=987550 https://doi.org/10.29202/phil-cosm/26/3

Volger, R., Timmer, M. J., Schleppi, J., Haenggi, C. N., Meyer, A. S., Picioreanu, C., ... & Lehner, B. A. E. (2020). Theoretical bioreactor design to perform microbial mining activities on mars. Acta Astronautica, 170, 354-364. https://www.sciencedirect.com/science/article/abs/pii/S0094576520300564 https://doi.org/10.1016/j.actaastro.2020.01.036

Wang, C., & Chang, Y. C. (2020). A new interpretation of the common heritage of mankind in the context of the international law of the sea. Ocean & Coastal Management, 191, 105191. https://www.sciencedirect.com/science/article/abs/pii/S0964569120301010 https://doi.org/10.1016/j.ocecoaman.2020.105191

Xu, F., Su, J., & Mehdi, M. (2020). A Re-examination of fundamental principles of international space law at the dawn of space mining. J. Space L., 44, 1. https://heinonline.org/HOL/LandingPage?handle=hein.journals/jrlsl44&div=6&id=&page=

قوانين وأنظمة التعدين الفضائي: تحليل مقارن للمعاهدات الدولية والتشريعات الوطنية

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الملخص:

مع تقدم التكنولوجيا والاهتمام المتزايد من قبل كل من الكيانات الحكومية والخاصة، انتقل التعدين الفضائي من عالم الخيال العلمي إلى احتمال حقيقي. الهدف الرئيس لهذه الورقة هو استكشاف الأنظمة القانونية المتعلقة بأعمال التعدين الفضائي. يحلل القيود والقيود القانونية المختلفة للعمل والمعيشة للقوانين الدولية والوطنية الحالية والقضايا الأخلاقية المتعلقة بموارد الفضاء. تماشياً مع هذا، فإن هدف هذا البحث هو تقييم ما إذا كانت الأدوات القانونية الحالية كافية وفعالة بما يكفي للتعامل مع القضايا المتعددة الأوجه المحيطة بالتعدين الفضائي. بالإضافة إلى ذلك، تهدف الورقة إلى التوصل إلى استنتاجات بشأن قدرة القوانين الحالية على حكم استغلال موارد الفضاء بشكل مناسب واقتراح تدابير لتعزيز صياغة تشريع مناسب بشأن هذه المسألة. يجب أن يهدف هذا الإطار إلى تحقيق التوازن بين حقوق المستخدمين في الاستخدام الرشيد والعادل لموارد الفضاء والالتزامات بالحفاظ على بيئة الفضاء الخارجي واهتمام عامة الناس. تستخدم الدراسة منهجية نوعية تتضمن تحليلاً نصيًا. تشير النتائج إلى الحاجة الملحة إلى قوانين دولية شاملة تعالج الاستدامة والتوزيع العادل للموارد. وتختتم الورقة باقتراحات بشأن الأطر القانونية المحتملة التي يمكن أن تحمي مصالح جميع الأطراف المشاركة في تعدين الفضاء.

الكلمات الدالة: التعدين الفضائي، الأنظمة، الإطار القانوني، معاهدة الفضاء الخارجي، اتفاقية القمر، القانون الدولي، السيادة، استخراج الموارد، حقوق الملكية، التأثير البيئي، الأخلاقيات، المصالح التجارية، التشريعات الوطنية، تراخيص التعدين.

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