



OPEN LUNAR
FOUNDATION

A Community Certification for Lunar Exploration

Operationalizing Community Guidelines
for Lunar Exploration

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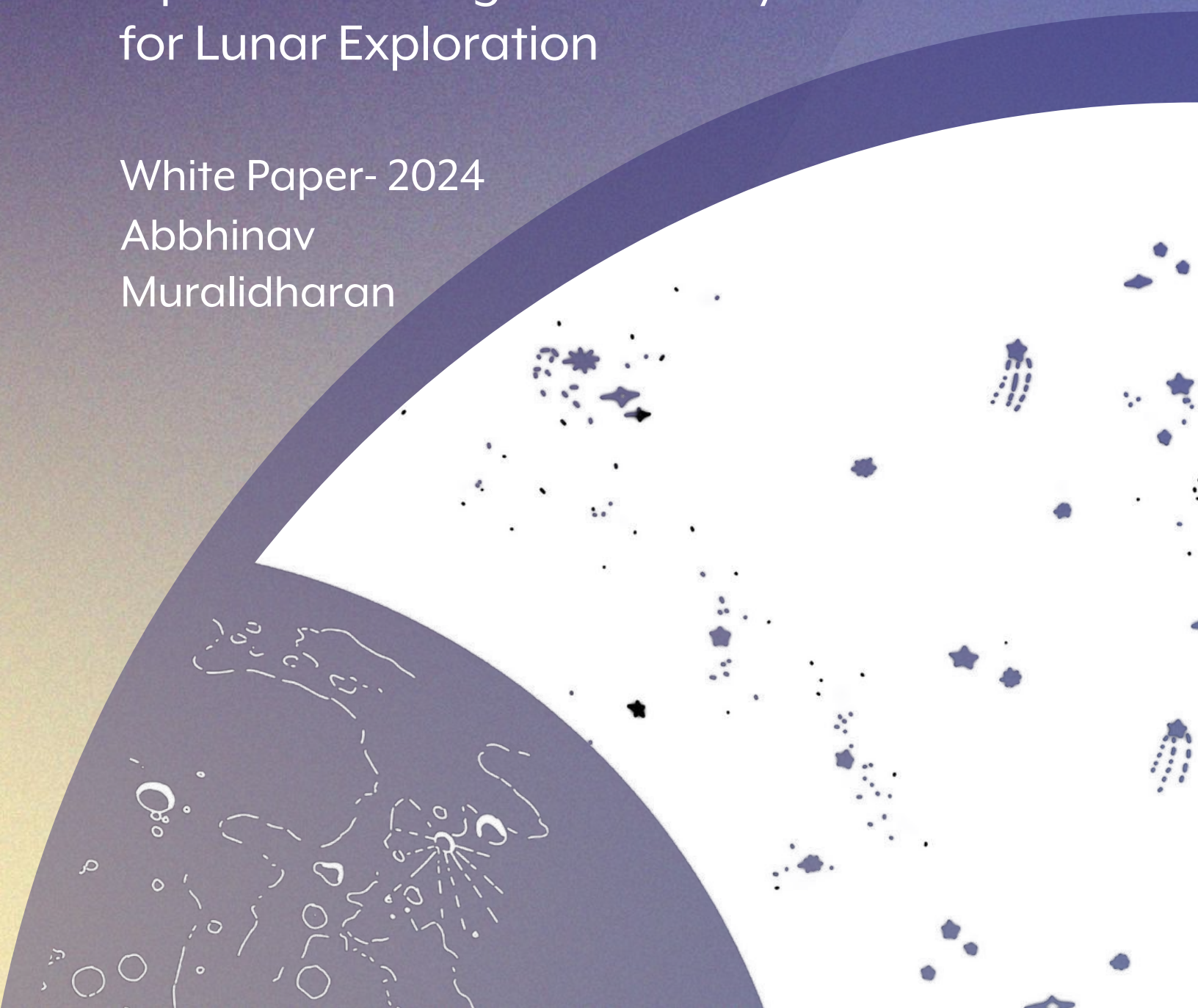


Table of Contents

Table of Contents	1
Disclaimer	2
Introduction	3
The Need for Community Input	3
The Challenge	3
Operationalizing Community Input	5
Why should you care?	6
Methods	8
The Current Landscape	9
Literature Review	9
Key Informant Feedback	11
Who is the Community? Defining the Stakeholders	13
Summary	15
Envisioning a Community Certification for Lunar Exploration	15
Motivation	15
Guiding Principles	16
Key Features	17
Output	17
Governance	20
Tiers of Engagement	22
Challenges	23
Guideline definition and prioritization	23
Lack of Operational Data	24
Stakeholder Buy-in and Market Appetite	24
Lack of Definition of Sociocultural Guidelines	24
Future Directions	24
Conclusion	26
References	28
Appendix A: Key Informant Questionnaire	33

Disclaimer

The views and opinions expressed in this paper are those of the author as part of a Research Fellowship at Open Lunar Foundation and do not reflect the opinions or views of any organization the author is affiliated with, including current and prior employers.

Introduction

The Earth has been shaped by its closest celestial neighbour in several ways. The Moon has influenced the Earth's climate and has shaped tidal patterns. The muse in the sky inspires tales, myths, songs, and art. Beyond its cultural and geological significance, the Moon presents opportunities for humanity. Scientific discoveries abound, commercial innovation in areas like in-situational resource utilization is not a dream of the distant future but an imminent reality, and the potential for a permanent human presence in space feels near.

The 2020s have been shaping to be one of the most consequential decades for lunar exploration. Several inflexion points in lunar exploration have accelerated humanity's return, and the cost of getting to the Moon has been drastically reduced through countless innovations. This increased access has allowed new players to enter the lunar "ecosystem" and attempt novel methods and techniques for accessing and exploring the lunar environment. Current efforts at exploring the lunar ecosystem have been focused on scientific objectives; while scientific advancement is one of the primary goals of exploration, what has been lacking is a mechanism to solicit community input in determining what is sent to the Moon.

The genesis of the Open Lunar Hunch [1] on a Community Review of Lunar payloads was in response to several lunar missions over the past few years. As the project developed through a review of existing guidelines and interviews with Key Informants, the project changed into one that provided two recommendations: creating a consortium to define a minimum set of guidelines for lunar exploration and creating a certification system to incentivise lunar actors to abide by the specified guidelines. This report addresses what these processes could look like, including motivations for these processes, potential governance models, and a few certification output types that would be most beneficial. This report will also highlight challenges with the proposal and offer steps to continue building this system for use by interested parties. Critical analysis of the specific sections is needed with the input of relevant stakeholders to ensure the process is standardized, rigorous, and drives trust-building in the community.

The Need for Community Input

The Challenge

There are estimated to be around 30 lunar missions [2] planned over the next few decades, a staggering number that would not have seemed possible even a decade ago. Recent missions and those planned include ones to increase precision-landing

capabilities [3], return samples of material from the Aitken Basin [4], a region of particular interest because it may contain material from the Moon's mantle, which would offer clues about the early solar system, a staging station [5] for crewed missions to the lunar surface, further exploration of lunar regolith and the presence of water ice in the south pole [6], and novel rovers that use legs [7] instead of wheels to reach challenging environments. The increased cadence of lunar missions is set to reap benefits for humanity on scientific, economic, and cultural fronts. It highlights an exciting paradigm for space exploration, similar to how Low Earth Orbit exploration ramped up decades earlier. However, not all missions have been pushing the bounds of human knowledge, and some have caused controversy in the community. A few examples are highlighted below.

The Sanctity of the Moon

In 2022, a payload sent to the Moon contained human remains [8]. This payload, on Astrobotic's Peregrine lander, caused deep concern for the Navajo Nation, who (along with several other indigenous communities) hold the Moon in a sacred position. This was not the first time human remains were sent to space. After the Lunar Prospector was sent to the Moon in 1998, carrying the remains of an astrogeologist [9], similar issues were raised by the Navajo Nation. NASA agreed to consult with the Navajo Nation before future missions carrying human remains. However, for the Peregrine Lander, NASA had contracted its scientific payloads on this lander and was one of the paying customers of an otherwise commercial mission. As such, NASA had no jurisdiction over the commercial payloads. In addition, there was no consensus-driven approach to sensitive payloads like human remains that actors could look to for guidance.

Exploration or Contamination?

In February 2019, a payload containing tardigrades [10] on the Beresheet mission crash-landed on the lunar surface. The fallout from this controversy highlighted the complexities of national licensing when launching international payloads, how scientific consensus is not always sought when launching payloads for scientific purposes, and how there is no standard expectation of communication to the public on the objectives of certain lunar payloads.

Re-Contact with the Past

As part of the Google Lunar X Prize's [11] goal to spur affordable access to the Moon, a "Heritage Bonus" [12] was offered, a monetary award to the first group to send photos and videos of Apollo landing sites. This bonus raised concern that teams attempting to win this bonus could inadvertently damage a site of cultural and historical

significance. The concern was enough to drive NASA, in consultation with space archaeologists, to publish non-enforceable guidelines and recommendations [13] for interactions with sites of historical importance, guidelines which are now reflected in the One Small Step to Protect Human Heritage in Space Act [14] passed by US Congress. After community input and guidelines from NASA, companies seeking to win the prize decided not to pursue the Heritage Bonus.

Operationalizing Community Input

The previous section used a few examples of contentious payloads to highlight a lack of community guidelines for what is being sent to the Moon. The contention surrounding the payloads was not that they were sent but that there was no systematic consulting and incorporating the community's input. This may seem like a complicated problem to solve; however, the concept of community input in managing technology, resources, and processes is not novel. A few examples are highlighted below.

Internet Engineering Task Force (IETF)

In 1986, the Internet Engineering Task Force (IETF) was established to balance conflicting [goals](#) [15] of rapid development of networking technology coupled with the desire for technical excellence with the principle of openness, fairness, and establishing widespread community consensus. This consensus was not only for the internet standards developed by IETF but for the process of developing standards itself [16]. The organization's purpose is to create standards to improve the interoperability and usability of the Internet, and it is comprised entirely of volunteers. Particularly of interest is the rough consensus [17] model, used as a consensus decision-making tool to indicate the general sense of the group regarding a matter being decided. One of the global impacts of IETF is the widespread adoption of the TCP/IP network protocol suite. By adopting the standard TCP/IP protocol, otherwise disparate networks could communicate with each other, which led to the growth of the Internet from a network of networks to the global resource we use today. With a standard set of guidelines and protocols, companies could innovate and build services on top of this infrastructure instead of focusing their energy on solving compatibility problems.

Fair Trade Certification

The Fair Trade Certification is a product certification [18] that strives to build a responsible, conscious consumer model to eliminate poverty and enable sustainable development for farmers and workers. Fair Trade empowers farmers and workers to form collectives, giving them collective bargaining powers and discouraging pricing

wars. Fairtrade Foundation [19] uses a Monitoring, Evaluation, and Learning (MEL) [20] program as part of its commitment to constantly improve its evaluation of how the Fairtrade certification benefits producer organizations, and uses a combination of regular monitoring of market progress, evaluating the existing Fairtrade process to learn and influence various aspects of the foundation, including the process of setting standards. The MEL program fully complies with The International Social and Environmental Accreditation and Labelling (ISEAL) Alliance, which seeks to strengthen sustainability standards for the benefit of people and the environment. ISEAL's Code of Good Practice for Sustainability Systems [21] is developed in consultation with stakeholders and overseen by a Steering Group in addition to a technical committee. The Steering Group serves in an advisory role to the technical committee and comprises members with expertise in credible and effective sustainability systems.

International Aid Transparency Initiative (IATI)

The International Aid Transparency Initiative (IATI) is a global initiative that aims to enhance transparency and accountability in international aid efforts. It was established in 2008 by donor countries, developing countries, civil society organizations, and multilateral institutions. Two organizations intrinsic to the functioning of IATI are Communities of Practice (COP) [22] and Working Groups [23]. COPs provide opportunities for stakeholders from various backgrounds to consult and collaborate to provide solutions to targeted areas in the aid landscape. Working Groups are comprised of technical experts who focus on developing and implementing IATI standards. Together, these two groups provide a means of soliciting community input and operationalizing that through implementing standards. The data and standards IATI produces have been used by governments like Madagascar [24], using the data to anticipate what donors are planning on spending several years in advance and using the funding optimally.

Why should you care?

In light of the recent upsurge in lunar missions, one might question the necessity of considering potential moral hazards [25] at this early stage. Addressing moral hazards at this stage could impede crucial technological advancements necessary to establish a sustainable Cislunar presence. This is a legitimate concern, and it will be critical to balance scientific integrity, community involvement, and the rapid pace of innovation. Looking back to the IETF model, the rough consensus of a Working Group [26] allows for streamlined decision-making while using consensus as the primary goal to ensure all voices are heard. Additionally, discussions about topics of interest to the IETF community (called Birds of a Feather [27]) can be used to gather

a sense of the community tangibly, regardless of whether or not a Working Group is created to address it.

Three arguments for why engaging the community has benefits have been highlighted below.

The Normative Argument

Engaging a broader community in striving for legitimacy is the right thing to do [28].

The role of norms is to provide agreed-upon tenets that guide actions [29]. Norms guide the behaviour of the community of actors and can form at various levels [30]. In an arena that lacks regulation, norms (like the Outer Space Treaty, which serves as the basis for national space laws) can serve as a tool that is more adaptable to the rapidly changing landscape [31] and one that can serve as a stopgap while treaties at the international level and regulations at the national level play catch up. Additionally, using community-driven guidelines to define norms helps operationalize treaties, which are authored to be broadly interpreted. An engagement of the broader community backed by concerned actors and encompassing the principles set by existing international frameworks can be used to define a responsible set of behaviours by all actors.

The Operational Argument

Engaging a broader community will enable the goal to be achieved [32].

The operational argument focuses less on process-based norms and more on outcomes [33]. Rapid expansion to the Moon without concern for the guidelines developed by experts in the community through a legitimate collaborative process could jeopardize public opinion on future lunar missions. Community involvement can help mitigate risks, technical and otherwise, which can help actors stay more informed and adaptable, making missions more resilient. Public engagement and knowledge sharing encourage private investment, garner more support from policymakers and the public, and open avenues for collaboration and educational initiatives. In addition to this, organizations that actively seek community input can enhance their reputation by demonstrating a commitment to community-driven guidelines and could potentially develop long-term relationships and partnerships with stakeholder groups comprising the community.

The Substantive Argument

Engaging a broader community recognizes the inherent value of integrating diverse perspectives into the outcome.

The concept of collective ownership and stewardship is crucial in the Substantive Argument for why participatory processes are essential. This argument was encapsulated by Elinor Ostrom's seminal work "Governing the Commons." [34] In this book, Ostrom explores common pool resources like fisheries, forests, and marine environments and identifies common factors contributing to the successful self-governance of said resources. A prominent one worth highlighting in this context is the concept of a **collective choice arena**: an arena that involves all stakeholders in the decision-making process and ensures that diverse perspectives are considered and that the community accepts decisions. One of the guiding principles of the proposed method, which is a core component of the self-governance model proposed by Ostrom, is the adaptability of this system; most stakeholders affected by this system can participate in its modification. Understanding the socio-economic and environmental contexts in which common pool resources are managed helps create effective governance mechanisms without needing external authorities to drive down top-down rules.

The primary goal of a participatory process is to help build social legitimacy by incorporating diverse perspectives from the community. These perspectives can help develop responsible behaviour, address ethical concerns, and, as a result, build trust. In the following sections, the concept of a participatory process will be built on with some additional considerations. The current landscape will be investigated first, including the challenges inherent in this landscape. Following this, a few proposals will be provided, along with challenges and next steps if the community wants to take this work forward.

Methods

As part of the project scope, existing literature on frameworks, regulations, and norms was reviewed. In addition to this review, key informants were identified for consultation precisely to characterize the interest of stakeholder groups that could be interested in providing input to this project and groups that would be directly impacted by the adoption of this system by the larger community. Eight semi-structured key informant interviews were conducted to determine any gaps in the literature review and ascertain community interest in a project of this nature. The key informants included Open Lunar Affiliates, members of industry with current or proposed lunar infrastructure projects, space lawyers, members of international

organizations focused on space exploration and governance, and members of space agencies. All interviews were conducted with Chatham House rules. Interviews included open-ended questions tailored to objectives. The model questionnaire used is attached in Appendix A.

The Current Landscape

Literature Review

The purposes of assessing the current landscape are multifold: to extract themes relevant to lunar exploration that could be measured for a lunar actor and identify success criteria for an actor to measure against.

Intrinsic to this research was the idea of “who gets to decide what gets sent to the Moon.” Looking to international treaties for guidance, the *Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, commonly referred to as the Outer Space Treaty (OST), makes this explicitly clear. Article I [35] of the Treaty enshrines the freedom of exploration and access: *Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.*

At the international level, several treaties exist that focus on lunar exploration. In addition to these treaties, guidelines like the UN COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities [36] developed at an international level provide guidelines on the long-term sustainability of space activities, which have applicability to the lunar environment. Multilateral arrangements like the Artemis Accords [37] provide a set of principles and best practices explicitly for lunar exploration, including topics of scientific data sharing and preservation of heritage sites. The Committee on Space Research (COSPAR), established by the International Council for Scientific Unions, publishes Planetary Protection Guidelines [38], which serve to “prevent contamination, not curb exploration” [38] and contain measures to prevent forward contamination of the lunar environment and backward contamination of Earth on lunar return missions. The International Space Exploration Coordination Group (ISECG) [39], a voluntary, non-binding coordination forum of space agencies, produced a Global Exploration Roadmap [40] to meet exploration benefits and generate public benefits, including objectives to “engage the public,” “stimulate economic prosperity,” and “foster international cooperation.” As recently as 2024, the Action Team on Lunar Activities Consultation (ATLAC) [41], a mechanism

within COPUOS, was proposed to increase “international discussion, coordination, and cooperation for cislunar and lunar activities.”

The *Recommended Framework and Key Elements for Peaceful and Sustainable Lunar Activities* [29] document published by the Global Expert Group of Sustainable Lunar Activities (GEGLSA) [42], a multi-stakeholder forum to discuss lunar exploration developed by the Moon Village Association, details existing international treaties and frameworks. The framework document also covers the limitations of these norms and proposed norms to be considered in the near term. Limitations are due to a lack of testing on the lunar surface due to the few missions that have explored the Moon. This limitation was also mentioned by several Key Informants and is explained in more detail below. The existing guidelines are broad, comprehensive, and often prescriptive. However, no forum is recommended where a lunar actor can measure against these guidelines comprehensively.

Nation-states are the primary subjects of international law and are ultimately responsible [35] for the activities and behaviours of companies operating under their jurisdiction. Looking at the United States as an example [43], three entities are tasked with licensing and regulating aspects of lunar payloads. The Federal Aviation Administration (FAA) under the Department of Transportation licenses launch and re-entry and reviews all payloads [44] to be launched or re-entered under a license to determine effects on public health and safety, the safety of property, national security, and any international obligations of the applicants. The Federal Communications Commission (FCC), an independent federal agency, licenses commercial satellite communications. The FCC also requires applicants to provide an Orbital Debris Mitigation [45] plan, including disclosure plans on how debris mitigation is intended to be performed. The National Oceanic and Atmospheric Administration (NOAA), under the Department of Commerce, licenses commercial remote-sensing satellite communications. It is worth noting that none of the above agencies have the remit to cover issues of ethics (by design) and are focused on matters of national security and the US government’s obligations to its international partners. For the US government, at this stage, legislation is intended to establish a process that is no more burdensome than is necessary to enable the US government to authorize pioneering space activities [46] in conformity with its treaty obligations and to safeguard core public interests.

At the industry level, while not specific to lunar exploration, actors have defined best practices and guidelines based on institutional knowledge gained through operations in the space environment. An example is the Satellite Orbital Safety Best Practices [47] released by several industry actors to codify cooperative discussions to “provide a foundation for discussions leading to a global consensus of behaviours for satellite operators.” These best practices were developed due to the increasing risk of

orbital debris caused by the exponential increase of satellites being operated in Low Earth Orbit and provides guidelines based on operational knowledge to prevent a further exacerbation of the existing problem. This example, while not directly related to lunar exploration, shows an example of bottom-up guideline development based on a common issue (orbital debris). As the number of missions conducted on the Moon increases, there are opportunities for similar “best practices” to be codified into community-driven guidelines.

In addition to existing frameworks, guidelines, and norms at international, multilateral, national, and industry levels, several guidelines exist on lunar exploration behaviours. While not an exhaustive list, the literature reviewed included documents focused more on technology and policy considerations [48] as well as the ethical and societal implications [49] of current efforts.

Key Informant Feedback

To supplement information gathered from the literature review, key informants were interviewed to determine the market maturity and “community appetite” for a certification mechanism of this nature. In addition to their assessment of the community’s interest in a certification process, informants were asked to provide focus areas they would consider to be the most important, with emphasis on the following:

- Time-criticality
- Tangible measurement criteria to weigh against
- Ability to showcase responsible behaviour to the larger community

The focus areas the key informants considered to be most pressing were:

- Environmental Considerations:
 - Planetary protection guideline adherence
 - Debris mitigation, especially as it pertains to end-of-life planning
 - Operations in areas of high scientific interest, like Permanently Shadowed Regions (PSRs)
 - Monitoring, particularly in pursuit of informing impacts to other stakeholders (for example, in better understanding plume-surface interactions)
- Sociocultural Considerations:
 - Preservation of heritage sites
 - Capacity building measures

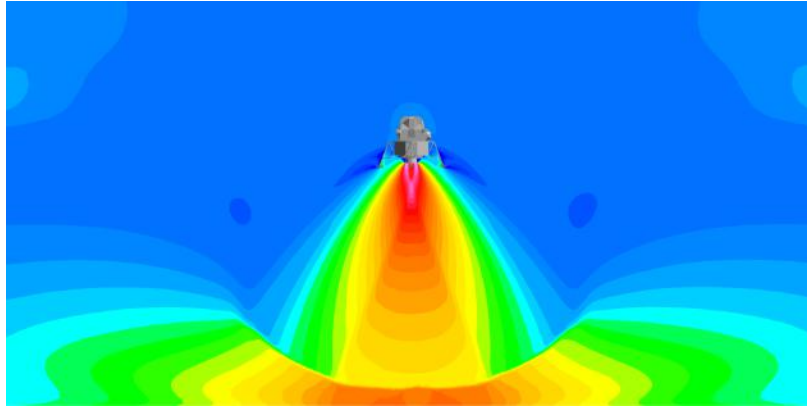


Figure 1. Plume Surface Interactions (PSI) visualization. Credit NASA



Figure 2. Neil Armstrong's footprint. Credit NASA/JSC

The key informants expressed varied interest in the need for a community-driven certification mechanism. Interestingly, key informant interest was correlated to their position on the stakeholder map, which will be discussed in more detail below. Primary concerns were:

- Lack of streamlined guidelines and prioritization
- Difficulty with stakeholder buy-in for a certification process not driven by regulation from national governments and the corollary concern that ethical guidelines should not be regulated top-down from national governments
- Lack of definition of sociocultural guidelines and concern of cultural considerations not encompassing the multitude of cultures that hold the Moon in cultural significance

Who is the Community? Defining the Stakeholders

Defining a set of stakeholders for an exercise such as a community certification ensures community members interested in lunar exploration, especially those traditionally underrepresented, have a voice. The stakeholders are, in essence, the formalization of a “town hall” participatory structure, and constant work is needed to modify and add to this community as the suite of lunar missions expands.

A stakeholder map was created through consultations with the Open Lunar community and Key Informants. Specific emphasis for the outlined proposal is placed in Quadrant IV (High Interest, Low Influence). Community members consulted for this from that quadrant were the only groups overwhelmingly supportive of the idea of a community certification system. This underscores the need to include voices from the community that are highly interested but do not have influence in traditional spaces. In Figure 3 below, **the groups in blue were groups from which Key Informants were identified and consulted for input into this proposal.**

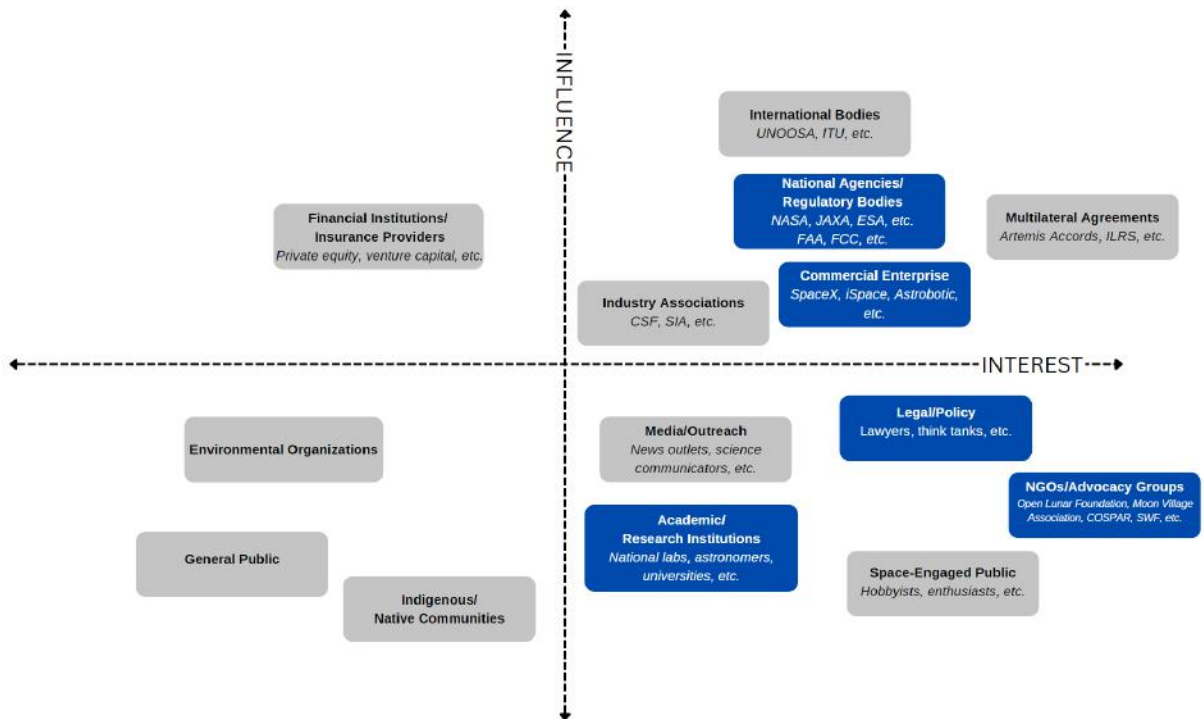


Figure 3. Stakeholder map

Stakeholder groups are listed below in no particular order, with examples provided:

- **International Bodies:** UNOOSA, COPUOS, ITU, IAC, etc.
- **National Government/Regulatory Bodies**
 - **National Space Agencies:** NASA, ESA, JAXA, ISRO, CSA, CNSA, etc.
 - **National Licensing Organizations:** NOAA Office of Space Commerce
- **Commercial Space Providers:** SpaceX, iSpace, Astrobotic, etc.
- **NGOs and Advocacy Groups:** Open Lunar Foundation, Moon Village Association, Secure World Groundation, National Space Society, COSPAR, For All Moonkind, etc.
- **Industry Associations:** Commercial Spaceflight Federation, Satellite Industry Association, etc.
- **Academic/Research Institutions**
 - **Research Institutions:** Lunar and Planetary Institute, National Labs, Astronomers, etc.
 - **Academia:** Universities
- **Media/Outreach organizations:** Washington Post, SpaceNews, social media science communicators, etc.
- **Public/Local Communities:**
 - **Indigenous/Native Communities:** Communities that hold the Moon in spiritual/cultural/religious significance
 - **Interested Public:** Hobbyists, space enthusiasts, etc.
 - **General Public:** Taxpayers, the public affected by space policy decisions
- **Financial Institutions:** Private equity, Insurance Providers, Venture Capital firms
- **Environmental Organizations**
- **Legal/Policy Groups**

Summary

Literature review and key informant consultations highlighted a few gaps in existing processes. Guidelines are well defined (although most key informants noted that guidelines at this stage of lunar exploration must constantly be re-assessed in light of experience gained from time spent in the lunar environment). Still, a means to measure against those guidelines is absent. The state, as the responsible party for space activities, could create regulations; however, almost all key informants agreed that it is premature for considerations highlighted to be under the remit of existing national governments, and concern was expressed that regulations could impede lunar exploration and will be rejected by a majority of the community. The response to the proposal of lunar actors seeking certification of responsible behaviour, driven by community-developed guidelines, was mixed. Still, concerns about this certification model centred more on buy-in by lunar actors (and perceived legitimacy) and lack of sociocultural guidelines, which is a concern that can be mitigated by robust community dialogue and incentivizing operators to buy into this model. The proposed solution is a community-driven certification, a stop-gap method that is quick, multi-stakeholder driven, neutral, and adaptive.

Envisioning a Community Certification for Lunar Exploration

Motivation

The need for community input has been highlighted, and current frameworks have been identified. The limitations of these frameworks are not so much in their inability to provide guidelines but the lack of incentive mechanisms for actors to follow said guidelines.

The proposal is twofold:

- The forming of a consortium of interested parties that will help streamline guidelines to a minimum viable product that existing lunar actors can operationalize
- The creation of an organization that can execute a certification process to certify payloads and operators to those defined guidelines

The proposal captures diverse perspectives and insights from within the community to encourage more socially responsible ways to explore. The consortium could be made up of scientists, engineers, policymakers, enthusiasts, and community members who have traditionally been underrepresented in conversations regarding

space exploration. The organization conducting the certification process could serve as an avenue to receive feedback from the community, provide a means to voluntarily adopt community-driven guidelines, and incentivize good behaviour as the number and complexity of lunar missions grow.

Guiding Principles



Figure 4. Guiding Principles of a Community Certification

Distilling the above into a core set of values/principles, here are the principles that drive a Community Certification for Lunar Exploration:

- **Neutrality:** The organization's decision should be based on objective criteria. Neutrality builds legitimacy and trust and encourages buy-in from the larger community.
- **Transparency:** By striving for transparency, following community-driven guidelines increases accountability. This helps build public trust and support for lunar exploration missions.
- **Accessibility:** For lunar actors, the certification guidelines and process should be made accessible and straightforward to encourage participation. The results of the certification will be accessible to the public. In addition, the certification itself will help build public support and trust for lunar exploration missions by demonstrating the above commitments. The certification will also serve as a benchmark to help with capacity building [50] for newer entrants to the lunar ecosystem.

- **Responsibility:** A certification driven by community input ensures that lunar payloads align with ethical principles and values of the community, including minimizing harm to the lunar environment, striving to meet the UN's Sustainable Development Goals, respecting heritage sites, and adhering to existing Planetary Protection guidelines.
- **Sustainability:** The certification process can be used to look past the objectives of a particular mission and consider the long-term sustainability impacts of lunar exploration activities. Agencies can use certification outputs to develop strategies to mitigate potential risks to future exploration and utilization of the Moon.

Key Features

- **Multistakeholder Design:** The organization is meant to be multi-stakeholder by design, allowing the certification process to strive for neutrality. This neutrality can drive the establishment of norms and behaviours in an era of competing multipolar frameworks [31] and striving for global reach.
- **Inclusive Representation:** The consortium and related certification body are designed to represent all interested stakeholders.
- **Consultative Processes:** The certification body's governance allows consultative processes to engage with different stakeholder groups based on their interest level.
- **Decision-Making Levels:** In the model of the Subsidiarity Principle [51], the organization is designed to encourage bottom-up decision-making, a key feature of multi-stakeholder design systems. Working Groups will comprise experts who will work on the addition/removal/editing of guidelines based on operational data and stakeholder input.
- **Decision-Making Velocity:** The organization will strive to be agile and adaptive, allowing for community input to be adopted strategically and responsive to the growing cadence of planned lunar missions.

Output

The output of this process will be a certification, indicating a payload adheres to guidelines of responsible behaviour and stewardship of the lunar environment and resources established by a consortium representing the community of interested parties. If modeled and incentivized appropriately, the certification could benefit lunar actors reputationally and operationally. By aligning themselves with these

guidelines and adopting a certification as outlined above, the first movers in lunar exploration could set the standards and influence other industry actors to align with their vision, creating greater market access, improving stakeholder relationships, and improving their public image to the larger community.

This certification could be modeled in several ways; two potential formats are highlighted below.

A Label of responsible resource use: The Forest Stewardship Council



Figure 5. FSC label [52]

The Forest Stewardship Council (FSC) is a global non-profit organization that ensures products with the FSC label bring the highest social and environmental [53] benefits to forests. Growing public awareness of forest destruction and degradation has increased consumer demand to buy wood and other forest products from forests known to be responsibly and well-managed. Hence, forest owners and managers are increasingly interested in proving and communicating their responsible practices to access these markets. In response to these demands from consumers and forest managers, forest certification schemes such as the Forest Stewardship Council (FSC) were developed and have grown. FSC is governed by members who are assigned to one of the three dimensions [53]:

- **Environmentally Appropriate:** Maintaining the forest's biodiversity, productivity, and natural ecological processes
- **Socially Beneficial:** Benefits to both local communities and society at large
- **Economically Viable:** Operations are structured and managed to be sufficiently profitable, balancing the long-term expense of the ecosystem and affected communities.

FSC members develop standards for responsible forestry management that are evaluated against the sustainability standards of ISEAL (the same sustainability standards organization used by the Fairtrade Association). A forest management organization applies to a certification body that uses FSC-developed standards to ensure that the organization conforms to FSC standards.

An extensive report [54] published by the World Wildlife Fund (WWF) detailed the economic impacts of FSC certification on forest operators, concluding that “on average, the companies examined earned an extra USD 1.80 for every cubic meter of FSC-certified Roundwood or equivalent, over an above new costs, through price premiums, increased efficiency, and other financial incentives” while noting that results varied by operation and geography.

A Social License to Operate: Socially Responsible Mining Practices

Gaining the Social License

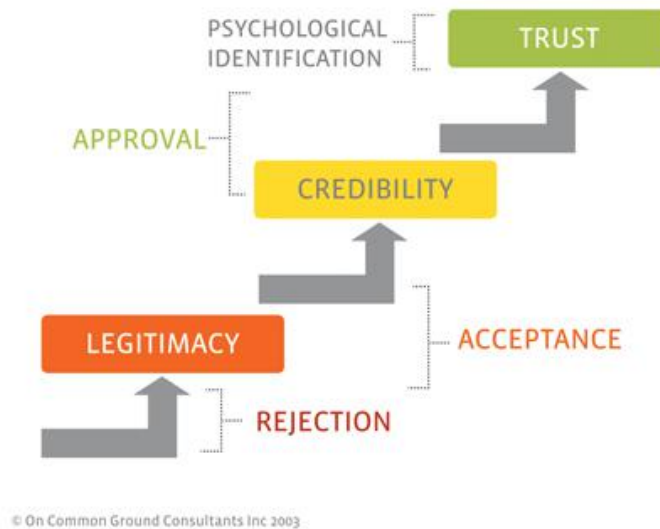


Figure 6. Social License to Operate process [55]

A well-known concept intertwined with corporate social responsibility in extractive industries like mining is the social license to operate (SLO) [56]. The Social License has been defined [55] as existing when a project has ongoing approval within the local community and other stakeholders, ongoing approval or broad social acceptance, and, most frequently, ongoing acceptance.

The notion traditionally reflects issues related to public acceptance of mining. It has become prevalent in the industry in the past decade, where it has slowly evolved to

encompass the evolving nature of the relationships between industries, communities, and stakeholders.

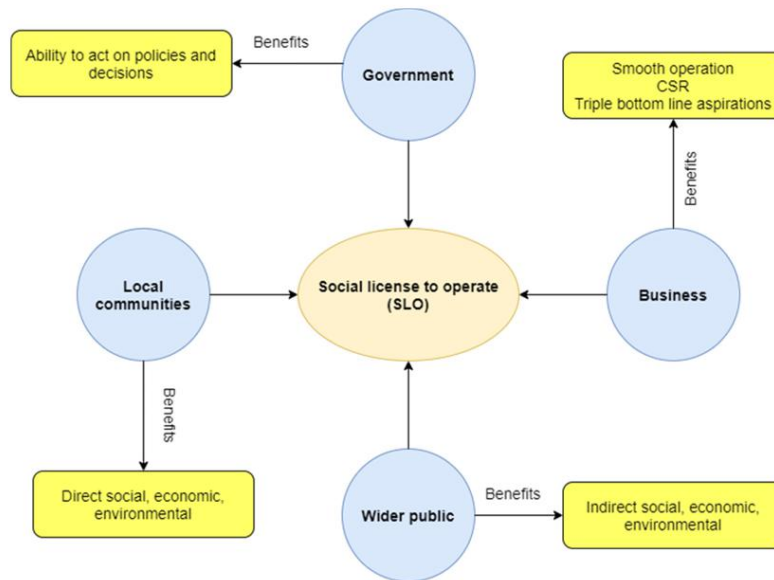


Figure 7. A model [57] of the various stakeholders that benefit from SLOs.

Using this model output, an SLO can be awarded to a lunar actor based on the community's agreed-upon criteria, and incentives can be baked into this license. This model will require national governments as providers of SLOs due to the nature of the activities planned by commercial entities [58] (per Article VI of the OST [35]) and, as a result, could be a more suitable output for a later phase of the proposed process, when guidelines are more mature and more stakeholders have bought into the process.

Governance

The governance structure of this operationalization of community input is critical to ensure decision-making on community input is neutral and independent. The recommended governance model starts with a consortium of interested parties in international organizations, national government, academia, and civil society. This consortium will define the creation of an independent organization with the organizational structure of a non-profit. Below is the proposed structure of the certification organization:

- **Executive Committee**

- Roles:
 - Implement the vision of the consortium, ensuring the certification process is transparent, neutral, and aligned with the determined guidelines
 - Adjudicate any additions, removals, or modifications of guidelines
 - Adjudicate any disagreements and disputes between the decisions of the different Working Groups
- Composition:
 - The membership of this committee should strive to reflect equal representation from different stakeholder groups and an equitable representation from international, national, academic, and civil society organizations
 - This will be a fixed-term appointment to allow for open seats to become available to interested stakeholders and to inject fresh perspectives

- **Stakeholder Advisory Group**

- Roles:
 - Serve as the representatives of the various interested stakeholder groups
 - Provide input and offer perspectives on the implications of guidelines being decided, following the “deference to expertise” [59] principle
 - Serve as a feedback mechanism for the Executive Committee
 - Engage in consultations with the community at appropriate intervals
- Composition:
 - Broad group reflecting the stakeholders identified, with mechanisms defined to continue increasing engagement with stakeholder groups
 - Could include representatives of stakeholder groups like international organizations, emerging national space programs, Indigenous organizations, environmental groups, commercial enterprises, and others



- **Working Groups**

- Roles:
 - Evaluation pertaining specifically to the Working Groups expertise to provide a more granular means of assessment
 - A Technical Working group would focus more on topics such as safety, impact on lunar environments, etc.
 - An Ethical Working Group would focus more on issues like heritage consideration, equitable resource access, etc.
- Composition:
 - Pre-defined based on focus areas or ad hoc for specific topics that require more in-depth conversation
 - Focus areas identified include Technical, Ethical, Cultural

- **Secretariat**

- Roles:
 - Support the day-to-day tactical operations of the Executive Committee, the Stakeholder Advisory Group, and the different Working Groups
 - Ensure accessibility to decisions and processes to the larger community
 - Maintain the organization's institutional knowledge, including documentation, meeting minutes, and notes on decisions made.
- Composition:
 - A small independent team of administrative professionals supported by legal advisers as needed

Tiers of Engagement

Engaging with the community can be at a variety of levels. Categorizing the tiers of engagement with the community will create a more tailored approach to community engagement that incorporates the influence and interest of various stakeholder groups.



Figure 8. Tiers of Engagement. Adapted from IAP2 2018 [60]

The model detailed in Figure 8 separates the engagement level with the public into various tiers, with an explanation of each tier on the left. On the right is an example of how that could look in the proposed governance of an organization building a certification system. Stakeholder groups that express less interest can be *informed* about the goals and objectives of upcoming lunar missions and their payloads, reflecting one of the guiding principles to strive for transparency. Groups that are highly interested but lack the institutional means to influence community guidelines could be more comprehensively *collaborated* with to increase engagement over time strategically.

Challenges

Guideline definition and prioritization

Common Key Informant feedback centred around the lack of defined guidelines for lunar actors to abide by. While various organizations have recommended guidelines, some Key Informants expressed a lack of awareness of guidelines they could strive to abide by outside of those typically followed (like Planetary Protection). This is not for lack of definition; guidelines exist in abundance through various frameworks, but efforts will need to be made to reach out and work with industry players to refine and shape existing guidelines into something more actionable.

Lack of Operational Data

Another challenge is providing metrics for these themes the community could rate against. One of the complications of this challenge is the lack of data, analysis, and knowledge gained through exploration. The exploration of the Moon is dwarfed in volume by the exploration of, for example, Low Earth Orbit, where operational data helps drive guidelines on topics of interest like debris mitigation. For example, the current driver for guidelines on Plume Surface Interaction is driven by analytical data. However, guideline definition and stakeholder buy-in could be challenging until more exploration is conducted and analysis is supplemented by test and operational data.

Stakeholder Buy-in and Market Appetite

While some Key Informants interviewed found the benefit of a set of guidelines working in conjunction with a certification, others expressed hesitation in being the first movers to abide by those guidelines. In general, widening social agency beyond the immediate actors in a given environment can be problematic for current actors. This could result in their ignoring the participatory mechanism [61]. Incentives, financial or otherwise, can help ease this problem but will need to be a highlighted feature of this process to encourage buy-in.

Lack of Definition of Sociocultural Guidelines

Reflecting the cultural values of humanity will require accepting a diverse slate of values that may, at times, be at odds with one another. Work will need to be done to determine what guidelines should be defined. These could range from addressing cultural sensitivities and providing an avenue for consistent reflection on humanity's core values for exploration [49].

The Global Expert Group on Sustainable Lunar Activities created a Tiger Team to tackle the issue of managing natural and cultural heritage. The team determined a set of suggested principles and guidelines [62] that provide a means to define cultural heritage and some mechanisms to manage heritage sites. In conjunction with community-driven guidelines, efforts like these could help address this challenge.

Future Directions

The content above has highlighted a gap in existing frameworks and regulations to aid in incentivizing responsible behaviours in lunar exploration. If the community desires this initiative, the steps below serve as a wireframe for achieving this goal.



Figure 9. Timeline for implementing the proposal

Phase 1: Consolidation, Field Testing

One of the first steps needed is to consolidate existing guidelines from different frameworks, including the ones highlighted above, into a streamlined set of guidelines (“checklist of considerations”) that will drive principles into action. Creating a minimal set of guidelines (Minimum Viable Product) will help with buy-in, and as legitimacy is built into this system, more guidelines can be added. Other international organizations have done consultations like this; in 2019, the Hague International Space Resources Governance Working Group performed a consultation [63] that led to the development of 20 building blocks for the development of an international framework on space resources activities. The consultation was conducted with industry involvement, which maximized commercial relevance.

A consortium of actors in the lunar space is recommended as part of this first step. A consortium of actors from national governments, international organizations, academia, and civil society will allow actors to operate independently but serve as a common knowledge-gathering forum, bringing a holistic view to and increasing the guidelines' legitimacy.

A Field test would be conducted with a targeted focus group of representatives from the stakeholders identified in the mapping. Testing the guidelines against past lunar payloads would serve as a benchmark of the guidelines and a signpost to undecided stakeholders regarding the benefit of signing up to engage in this process.

At the end of this phase is the inflexion point of this proposal; depending on industry appetite, the work could conclude with determining a streamlined set of community-driven guidelines or developing an organization that can certify payloads to those guidelines.

Phase 2: Governance, Mechanisms, Incentives

Once a consortium is created, governance will need to be established. Establishing a neutral, adaptable, and transparent governance structure will encourage buy-in from the larger community and allow the initiative to be iterative and adapt as the community learns more from planned lunar missions.

In parallel, consultative mechanisms will need to be established. The format of the mechanism (written form, questionnaire, etc.) will be finalized, and stakeholders in the consortium could serve as the first users of the determined mechanism to provide feedback.

Incentivization is a crucial component of a system like this to strive for success. Incentives provide lunar actors tangible benefits to agree to community-built guidelines. Incentive structures will need to be established, and they could vary depending on the types of activities being conducted by operators, from anything to financial incentives, administrative privileges, and cost-sharing efforts [58].

Phase 3: Lessons Learned, Measure, Improve

This phase will formalize a governance model and begin executing the consultative mechanism. More guidelines can be baked into the governance and processes as more legitimacy is built into the process. This would resemble the Monitoring, Evaluation, and Learning (MEL) [20] program discussed in the Fairtrade example above. Once the certification is a standard institutionalized process, further work will be routine monitoring and delivery of results. Results can be evaluated quantitatively and qualitatively to ensure the vision of the Executive Committee is being implemented as intended. In parallel, assessments can be done as more is learned about lunar exploration to add, remove or modify guidelines.

In addition to this, strategic alignment with other Open Lunar projects, specifically the Lunar Registry and Lunar Accidents, Incidents, and Issues Reporting System (LAIIRS) [64] and the Global Registry of Lunar Objects [65], will be sought out to provide a cohesive governance framework to identify objects being sent to the Moon, offer community guidelines on their use, and report on accidents and lessons learned to inform future guideline development.

Conclusion

This paper discussed the motivations behind the Open Lunar Hunch of a community review by interested parties in response to a lack of community solicitation on

objects sent to the Moon. The paper provided details on the background research that shaped the project into a Community Certification, which serves as a way to incentivize good behaviour and align those good behaviours with guidelines developed by the community. The proposal was two-fold: the creation of a consortium of interested parties to streamline existing guidelines and propose new ones into a viable set that existing lunar actors can use to measure against their mission design, and the subsequent creation of a neutral, third-party organization to conduct a Community Certification of payloads modelled on certifications of responsible use similar to the ones prevalent in the environmental and mining industries. Challenges associated with this proposal were highlighted, along with mitigating steps where possible.

Community input can benefit the varied goals and aspirations for humanity's exploration of the Moon. Involving the community shapes the conversation to ensure lunar exploration efforts reflect our shared values. It is critical to ensure this input does not impede but enhances the rapid pace of innovation in research and exploration that will be occurring over the next decade. Exploration is a human pursuit, and it benefits the community to determine the values enshrined in this extraterrestrial adventure. As humanity expands its presence on the Moon, determining a participatory process drives intent to the goal of doing so as in the image of humanity.

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Appendix A: Key Informant Questionnaire

Motivation for Questionnaire:

Input solicitation is prior to the definition of review details. Pertinent for norm-building is soliciting input from the community prior to informing the community after implementation.

Key Informants with payload review experience

- Why was your payload review process needed? What problems did it solve?
- What logistical, safety, and ethical considerations were at play when creating your systems?
- What kind of governing body is in control of your process? What types of stakeholders are involved? Do you think a multistakeholder process would be successful? Any lessons learned from multi-stakeholder engagement?

General Questions

- Do you think a community review of lunar payloads is required? If so, why?
- What do you think the public/private sector appetite is currently for a community review?
- What do you think are steps the review board could take to encourage buy-in from payload operators (operator incentives)?
- Do you have any recommendations on Earthly analogies to a community-style review?

Review Goals

- What kind of gaps do you envision this review fill?
- What would you define as the appropriate *community* for this review?
- How do you envision this review adding “Value Beyond Compliance” or Shared Value?

Review Content

- What kinds of categories/modules would you want the review to focus on? (Eg. Disposal plan, compliance with standards, data sharing, etc.)



- Food for thought:
 - Management plan (mission plan, end-of-life disposal, etc.)
 - Preservation (historical sites, religiously significant sites, etc.)
 - Indigenous People's rights (The legal and customary rights of indigenous peoples to own, use, and manage their lands, territories, and resources shall be recognized and respected.)
 - Data Release (transparency)
 - Interoperability of infrastructure
 - Preservation of finite high-value commodities
- What would be the output of the review? (Eg. Score, yes/no, red/green/yellow, etc.)

Review Mechanics

- What is the preferred Entry Mechanism?
 - Form filled out by the operator
- What are the mechanisms for involving the community? What does involvement and/or engagement mean in practice?
- Depending on how broadly we define "community", how do we operationalize community involvement?