Towards a Safe and Sustainable Cislunar Space

Policy Priorities for European Engagement

ESPI European Space Policy Institute

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1 EXECUTIVE SUMMARY

The number of planned lunar missions is rapidly growing

With humanity returning to the Moon, **a new wave of missions is turning cislunar space into a strategic frontier**. After a roughly three-decade lull in lunar activity, the number of ongoing and planned missions to cislunar space has increased significantly. While Europe's participation is at a much lower frequency and scale than that of most global space powers, the *Revolution Space* report delivered by the High Level Advisory Group to ESA in 2023 called for an increased European ambition in exploration, with the Moon at the core of their recommendations.

With or without Europe, this surge in ongoing activities reflects a **transformative shift, marking lunar exploration as a growing priority** for spacefaring and space-aspiring nations, with Europe having a generational opportunity at the 2025 ESA Ministerial Council to boost its technological, cultural and economic relevance in the world through an increased lunar ambition. In this context, Europe has the **opportunity to address cislunar safety** as an integral part of a reinforced exploration ambition, de-risking future European institutional and commercial missions alike. This study, thus, aims to bridge the divide between technical and policy conversations, **assess Europe's approaches to the safety and sustainability of the cislunar environment, and identify potential arguments in support of European action on cislunar safety.**

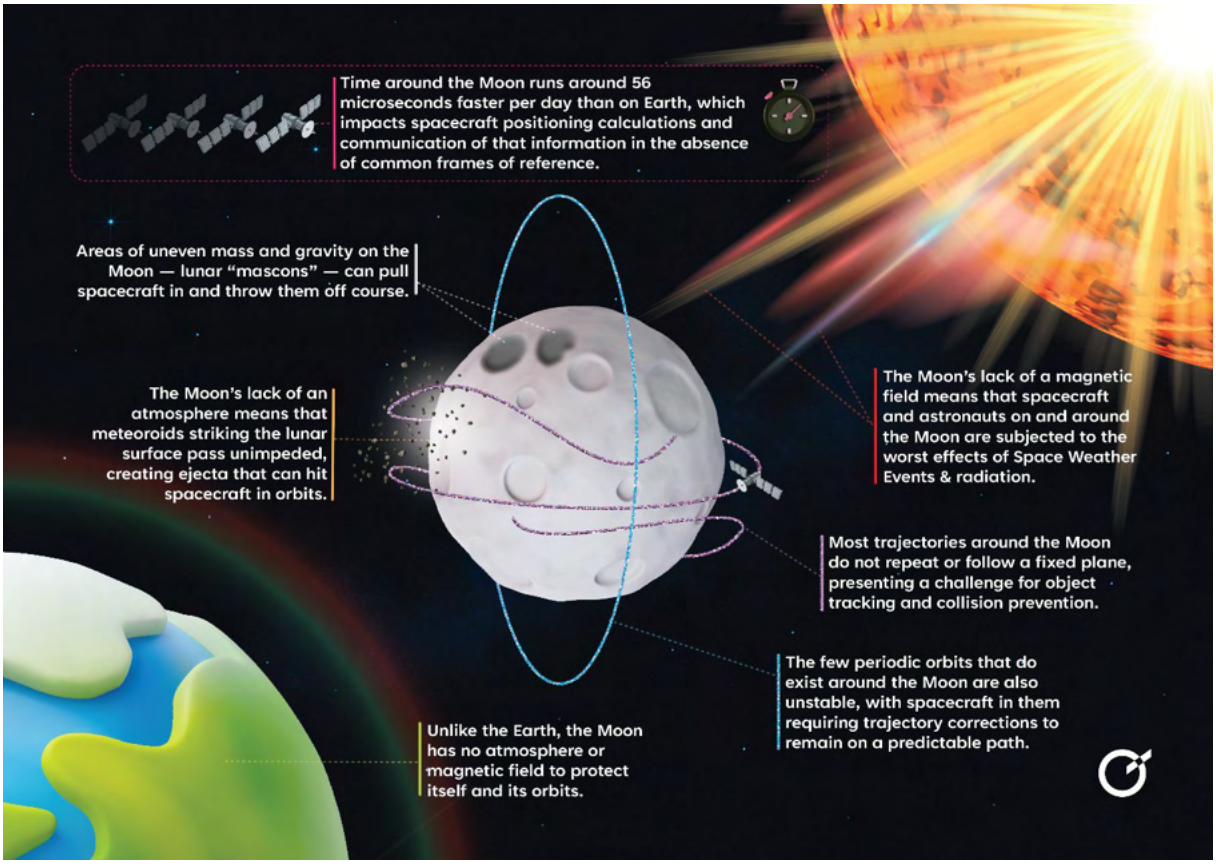

Figure 1: Key challenges of the cislunar environment

Today, lunar missions operate in a highly risky environment and often fail, due to both external factors at play in the unique cislunar environment (see Figure 1) and the lack of infrastructure providing missions with critical information at the required level of detail and consistency. Some of the technical challenges posed by the cislunar environment include **the need for better, space-based Space Situational Awareness, including lunar PNT and communication services**, the lack of which might result

in higher collision risks as missions multiply. **The absence of sufficient research and observation related to Space Weather Events** also affects the overall safety conditions of planned missions. Finally, the natural instability of lunar orbits **poses a risk for the proliferation of space debris**, demanding dedicated mitigation and end-of-life approaches. Such cislunar safety capabilities are currently underdeveloped, considering a projected increase in lunar activities, and are in need of further investments and innovation to ensure the safety of assets and astronauts in cislunar orbits.

Lunar missions are currently not sufficiently de-risked

Such investments would allow Europe to proceed with lunar exploration efficiently and effectively, achieving the broader space policy priorities it has set for itself. Per national policy and strategy documents as well as statements at the UN, EU and ESA, Member States view lunar exploration as synergistic with declared space policy interests, such as commercialisation, norm-setting and the pursuit of general sustainability interests. International counterparts also view lunar exploration as aligned with their space policy priorities, notably international leadership.

According to the results of a survey conducted for this study, **stakeholders in Europe and internationally believe that cislunar safety action is an integral element of an increased exploration ambition**. Furthermore, based on the analysed policy documents, including national and multilateral policies and strategies, **the mentions of cislunar safety issues have increased in frequency over the years**, reflecting an increasing interest within the European and international community. **Yet, action on cislunar safety at large has remained haphazard, characterised by a lack of streamlined concerted efforts**.

Thus, considering the value lunar exploration can bring to Europe, and in line with the identified policy priorities in formal documents, public statements and interviews, **key arguments advocating for European action in cislunar safety emerge.** These arguments incorporate various synergies with other strategic space policy priorities in Europe, including a push for more security-related assets.

Without further safety developments, planned European institutional and commercial lunar missions will have a higher risk of failure

Promoting cislunar safety investment enables greater strategic autonomy in space and advances European technology

Demand for cislunar safety services can enable further commercial investments and strengthen commercialisation

Cislunar safety investments would help Europe take the lead on sustainable and responsible approaches to lunar activities and scientific exploration

Cislunar safety action can help Europe position itself in international norm- and standard- setting

Considering the importance of safe lunar exploration to the world's space powers **and given the calls for an increased European engagement in lunar exploration, Europe's question should no longer be whether or when to act, but instead how to do so most effectively. Some key first steps, in the context of cislunar safety, could include:**

Investment into space-based SSA infrastructure

Agreement on end-of-life and debris mitigation procedures

Further experimentation and research for space weather forecasting

2 ABOUT THE REPORT

Humanity is returning to the Moon. After a roughly three-decade lull in lunar activity, the number of ongoing and planned missions to cislunar space has surged, turning the Moon once again into a coveted destination (see Figure 2).

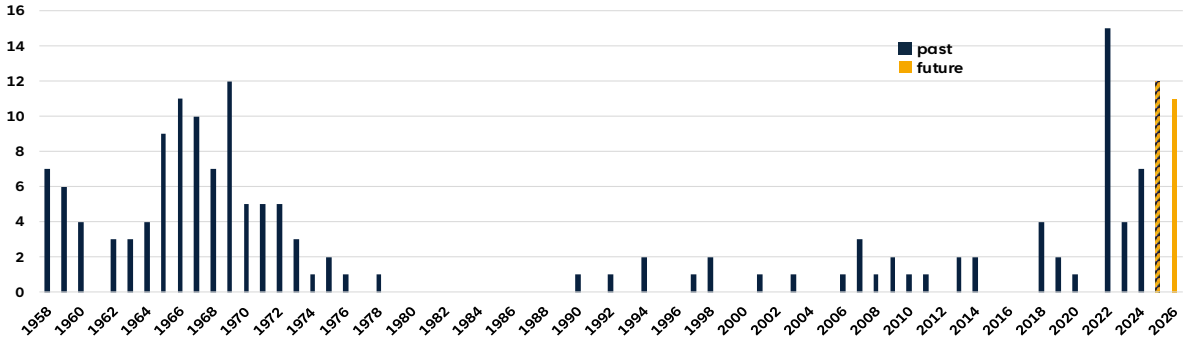

Figure 2: Timeline of past and planned missions to cislunar space (updated from ESPI Report 86, 2023)

Compared with the 20th century, however, some of the planned missions tend to be far more ambitious in their volume and scope. Moving past steps on the Moon's surface, today's push envisions **establishing a long-term sustainable human presence on the Moon and creating a full-scale lunar economy**.[1] Yet, among other challenges facing these ambitions, the current dearth of dedicated cislunar safety infrastructures and policies adds to the difficulty of achieving these goals. Since the early days of lunar exploration, just over 50% of missions have succeeded in part due to external safety issues.[2] Most recent examples of unsuccessful missions include NASA's Lunar Trailblazer and AstroForge's Odin flyby mission in February 2025 that failed partially due to communication issues, as well as the ispace Hakuto-R Mission 2, carrying Tenacious, a rover that hoped to become the first European-built rover on the Moon.[3] Thus, as plans for lunar exploration advance in volume and ambition, **addressing cislunar safety and sustainability challenges is becoming a necessity to derisk future missions.**

Beyond Communications, critical issues include a lack of Space Situational Awareness infrastructures, potential formation and re-entry of space debris, and radiation impacts. Regulatory and policy developments also lack clear frameworks created specifically for the cislunar context. For example, the fact that the Outer Space Treaty and the Registration Convention lack a requirement to share information about activities *in orbit* can particularly negatively affect safety on and around the Moon because close approaches cannot be easily predicted. Though the Outer Space Treaty's Article IX demands that activities that might harmfully interfere with those of other parties be discussed in advance, the lack of existing norms surrounding such consultations and the nascency of large-scale lunar exploration leave that requirement open to interpretation.[4]

These and many other questions require solutions from both technical and policy perspectives to ensure that risks associated with humanity's return to the Moon are mitigated as early as possible, for the benefit of sovereign, commercial and scientific objectives. Yet, **despite the increase in missions and a multitude of challenges, there is little extensive research on cislunar safety and sustainability topics**. Furthermore, even where research exists, it tends to be dominated by U.S. perspectives and focuses on the technical problems, sidelining policy conversations that will be necessary to ensure system, mission, and astronaut safety as actors in the cislunar environment diversify. Existing research also largely

[1] European Space Policy Institute. Space Safety and Sustainability Momentum. ESPI, 2023 (Link); PwC. Lunar Market Assessment: Market Trends and Challenges in the Development of a Lunar Economy. September 2021 (Link)
[2] Gail Iles, "Almost half of Moon missions fail. Why is space still so hard?" *The Conversation*. , 25 Aug. 2023, (Link)
[3] Jeff Foust, "Lunar Trailblazer, Odin spacecraft suffering problems after IM-2 launch" *SpaceNews*. , 28 Feb. 2025, (Link)
[4] Jessy Kate Schingler, et. al, "Don't Delay Getting Serious About Cislunar Security" *War on the Rocks*. 6 Jul. 2022, (Link)

focuses on the U.S. and China, neglecting to assess the role Europe can play in cislunar safety and sustainability.

2.1 Objectives, Scope & Methodology

In light of the identified research gaps, **the rationale for this study is to bridge the divide between technical and policy conversations, assess Europe's approaches to cislunar safety and sustainability, and identify arguments in support of European action on cislunar safety**. The study's principal aims, thus, are:

- To evaluate the key safety challenges in the cislunar environment based on an extensive literature review;
- To map policy positions and existing programmatic action in cislunar safety to assess priorities in cislunar safety and identify gaps in safety-related developments;
- Formulate cogent arguments supporting European action on cislunar safety based on identified key policy concerns.

The study provides an overview and analysis of cislunar safety pursuit across all EU and ESA Member States, as well as across six non-European countries that have been most prominent in lunar exploration in recent years. In total, the pursuits of 36 countries were analysed. The countries are, namely:

Europe					
Austria	Czech Republic	Germany	Latvia	Poland	Spain
Belgium	Denmark	Greece	Lithuania	Portugal	Sweden
Bulgaria	Estonia	Hungary	Luxembourg	Romania	Switzerland
Croatia	Finland	Ireland	Malta	Slovakia	The Netherlands
Cyprus	France	Italy	Norway	Slovenia	The UK
Non-Europe					
The United States	China	India	Japan	South Korea	Russia

Table 1: Analysed countries

To further inform the study on stakeholders' positions and priorities, a survey, a consultation campaign, and a closed-door workshop as a side event to the 2025 Legal Subcommittee of the United Nations' Committee on the Peaceful Uses of Outer Space were organised. A concise explanation of the methodologies used is described in the note box of each section, and, more extensively, in Annex B.

Figure 3: Summary of the Project methodology

3 TECHNICAL AND ENVIRONMENTAL CHALLENGES IN CISLUNAR SPACE

Safety challenges in cislunar space stem largely from differences in its physical properties and dynamics compared with those present around the Earth. A brief recap of these differences follows to provide **a short background on how the cislunar safety challenges impact space missions.**

> For the purposes of this Report, cislunar space is defined as the region between the Earth and the Moon, including the orbital environment around the Moon. [5]

3.1 Cislunar Environment's Properties and Dynamics

The key properties of the cislunar environment relevant for operational safety include its orbital dynamics, as well as its lack of an atmosphere and time difference compared to Earth. The issues are summarised in the visual below (see Figure 4), with the information on the challenging orbital dynamics expanded upon in the following subchapter.

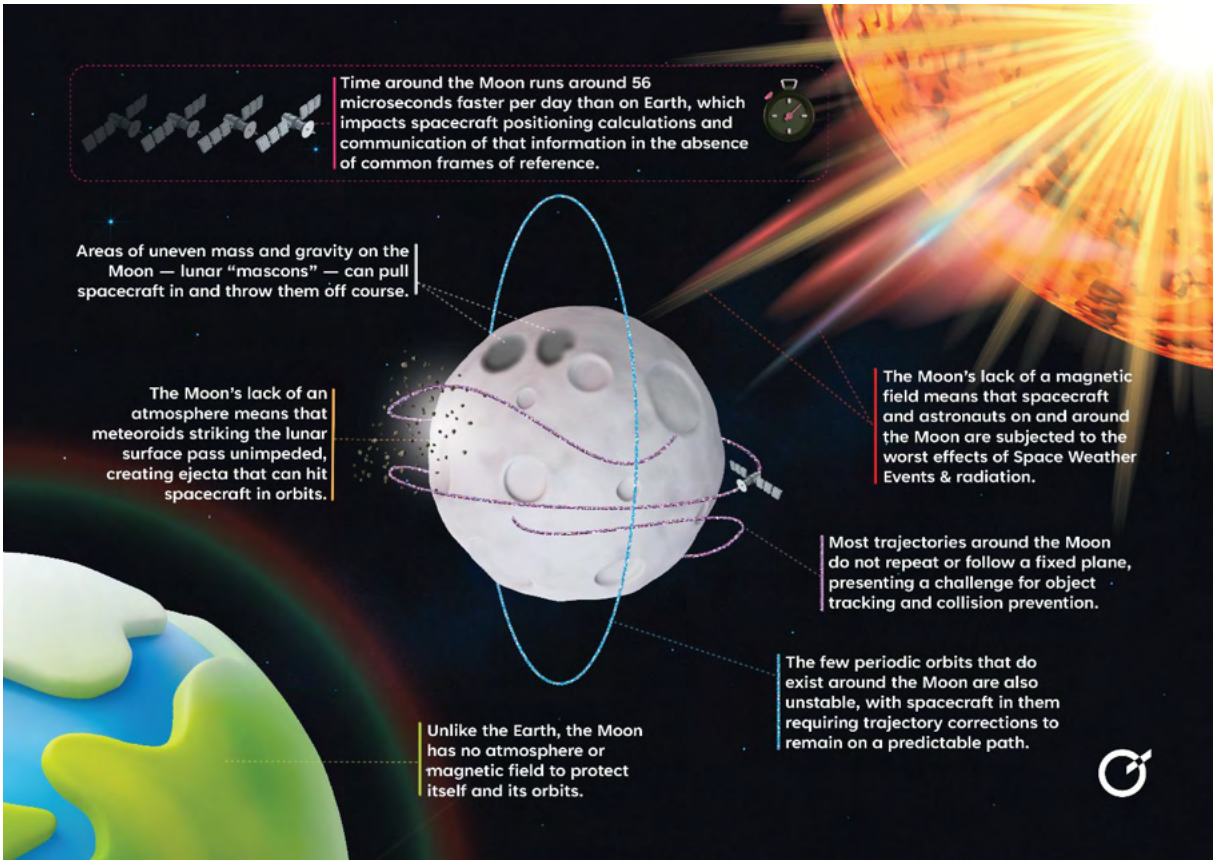

Figure 4: Key challenges of the cislunar environment

3.1.1 Orbital Dynamics

Objects in most lunar orbits behave differently from those orbiting the Earth. **Cislunar orbits are largely non-periodic and unstable**, complicating any cislunar mission and safety initiative.

Issues Impacting Orbital Trajectory and Predictability

In Earth orbits, standard Keplerian rules apply, and the relationship between a spacecraft and the Earth is an easily solvable "two-body problem" where object trajectories can be predicted and described. In

[5] Definition per ESA, see for example European Space Agency, "ESA Space Environment Report 2025," 1 Apr. 2025, (Link)

lunar orbits, however, a third body — the Moon itself — joins the equation. In this scenario — the "Circular Restricted 3-Body Problem" (CR3BP) — **most trajectories cease to repeat, do not follow a fixed plane, and show generally chaotic behaviour** because the Earth and the Moon now tug on the spacecraft with competing gravitational pulls.[6] In addition, Earth's gravitational pull becomes particularly dangerous for spacecraft orbiting at higher altitudes above the Moon, as it can spin them out of their predicted paths, while movement in Low Lunar Orbits (LLOs) is particularly affected by the gravity of the Moon itself. The Moon is dotted with so-called "mascons" (mass concentrations) that are so dense in some areas that they can affect the Moon's gravitational pull, either pulling spacecraft in and crashing them into the lunar surface or throwing them off course.[7] The LLOs' proximity to the surface makes it easier for mascons to affect spacecraft stationed in them. Taken together, the Earth's gravitational pull and the lunar mascons make most lunar orbits non-periodic, with objects in them prone to unexpectedly transferring orbits, crashing into the Moon, or flying off into deep space. This means that **most lunar spacecraft will be concentrated to some extent in a limited number of periodic orbits and more "stable" areas in cislunar space,** begetting potential congestion**.**

Periodic Lunar Orbits and "Stable" Areas

Despite the orbital dynamics affecting spacecraft around the Moon, there are several areas and orbits where their movement can be more confidently predicted. **Key among them are orbits making use of the five Lagrange points (L1, L2, L3, L4, L5) where the gravitational pulls of the Earth and the Moon balance out to keep the spacecraft moving with the two bodies.**[8] Though normally called Lagrange "points", they can be more aptly visualised as areas, since they comprise large swaths affected by the same gravitational dynamics.[9] **The stability of the Lagrange points allows for periodic orbits to occur in their vicinity**.

Beyond orbits around the Lagrange points, several other largely periodic orbits have been proposed, such as the elliptical frozen lunar orbits, a subset of LLOs.[10] Quasi-periodic orbits — orbits that stay within the "neighbourhood" of a periodic one but never quite repeat their trajectories — can also be utilised as more "predictable" ones for lunar missions.[11] Yet, spacecraft in them will still require trajectory corrections because if spacecraft in a lunar orbit deviate from their path ever so slightly, the deviation is likely to compound, potentially throwing them entirely off course. **Only small volumes of space around L4 and L5 allow for a spacecraft or other objects to remain in a fully predictable path for longer periods of time.**[12] Still, though orbital instability makes it difficult to keep spacecraft on a predictable path, **it makes it easier and less costly to transfer spacecraft from one orbit to another** by utilising the unstable motion already throwing off the spacecraft.[13] Balancing the environmental challenges with such opportunities will be key for safe and sustainable lunar exploration.

3.2 Safety, Security and Sustainability Challenges

Largely based on the properties and dynamics of the cislunar environment, several key safety, security and sustainability challenges emerge for spacecraft and astronauts in lunar orbits. A non-comprehensive list includes Space Situational Awareness (SSA) and Space Traffic Management (STM), Space Debris and End-of-Life, and Space Weather events.

[6] M. J. Holzinger, et.al. A Primer on Cislunar Space. Air Force Research Laboratory, 2021, (Link), p. 5
[7] Denise Chow, "Mystery of Moon's Lumpy Gravity Explained" *Space.com*, 30 May 2013, (Link)
[8] NASA/WMAP Science Team, "What is a Lagrange Point? - NASA Science" *NASA*., 27 Mar. 2018, (Link)
[9] Jessy Kate Schingler, et. al, "Don't Delay Getting Serious About Cislunar Security" *War on the Rocks*. 6 Jul. 2022, (Link)
[10] Brian Baker-McEvilly et al., "A comprehensive review on Cislunar expansion and space domain awareness" *Progress in Aerospace Sciences*. 147 (2024): 101019; p. 5 & 20
[11] M. J. Holzinger, et.al. A Primer on Cislunar Space. Air Force Research Laboratory, 2021, (Link), p. 9
[12] M. J. Holzinger, et.al. A Primer on Cislunar Space. Air Force Research Laboratory, 2021, (Link), p. 10
[13] M. J. Holzinger, et.al. A Primer on Cislunar Space. Air Force Research Laboratory, 2021, (Link), p. 20

3.2.1 Space Situational Awareness and Space Traffic Management

With the growing number of lunar missions, ensuring adequate SSA and STM will be critical to enabling spacecraft and astronaut safety. A moderate increase in orbiters in similar LLOs over the last few years has already significantly increased the number of collision close calls between various cislunar spacecraft (see Figure 5), sometimes forcing their operators to perform avoidance manoeuvres. It is expected that the number of such close calls will only increase as more missions enter lunar orbits, demanding better SSA and concerted efforts on STM.[14] Yet, the nature of the Earth-Moon system presents a **unique set of challenges to address for enabling efficient and effective cislunar SSA and STM.**

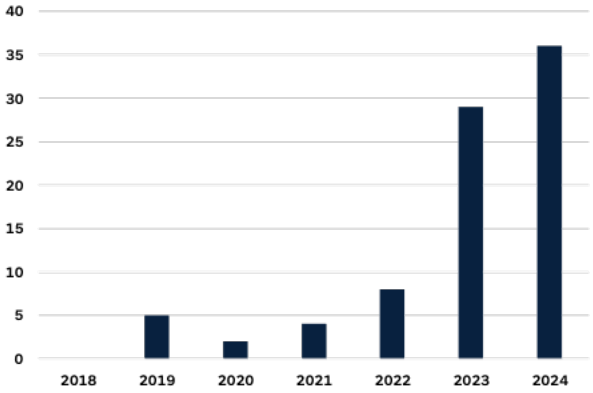

Figure 5: "Close calls" for orbiter collisions around the Moon since 2018 (Source: NASA JPL)

Locating the objects is the main issue. In a 3-body environment, one cannot always confidently predict where an object will go unless it is in one of the verified, roughly "stable" orbits, demanding different approaches to SSA and STM from those employed around the Earth. Currently, cislunar objects are mostly tracked via various techniques through ground-based stations, but these methods face several limitations, such as the lack of passive tracking and the existence of the so-called "cone of shame" around the Moon — an area where its glare prevents instruments from seeing the objects within.[15] Considering the issues with Earth-based tracking, **enhancing space-based tracking technologies will be key** to ensuring safety from collisions in the cislunar environment.

Cislunar space is also vast and almost impossible to observe in its full volume. Thus, clear choices need to be made about which sectors are relevant for SSA and STM purposes. Even with an increase in traffic, missions are going to be concentrated in several key areas, so actors should identify key regions of interest to focus their tracking efforts on.[16]

Beyond issues with tracking, collision risks grow because of **communication and policy gaps.** The Two-Line Element Sets (TLEs) traditionally used to encode and easily share locations of objects in Earth orbits can no longer be effectively used for cislunar objects.[17] **Novel uniform methods of encoding spacecraft positions in cislunar space will therefore be required** to ensure clear communication and STM.

> Devising clear communication practices and ultimately STM will be crucial to avoid misunderstandings and accidents, **particularly due to the difficulty of establishing the intent in cislunar space — that is, whether a potentially dangerous manoeuvre occurred by an operator's choice or simply due to an orbit miscalculation or another external issue.**

To ensure long-term sustainable activity in cislunar space, SSA capabilities and STM will have to be complemented by consistent Positioning, Navigation and Timing (PNT) and

[14] Zahi B. Tarzi et al., *Deep-space Conjunction Assessment: Recent Developments and Future Evolution NASA.*, 2024, (Link), pp. 5-6; Courtney Kirkpatrick and Daniel Hastings, "An Analysis of Space Traffic Management Needs in Low Lunar Orbit" in *AIAA Aviation Forum and Ascend*, 2024 (Link)
[15] Zahi B. Tarzi et al., *Deep-space Conjunction Assessment: Recent Developments and Future Evolution NASA.*, 2024, (Link), p. 2; Vishnu Reddy, "More lunar missions means more space junk around the Moon – two scientists are building a catalog to track the trash" *The Conversation*, 6 Feb. 2023, (Link)
[16] Brian Baker-McEvilly et al., "A comprehensive review on Cislunar expansion and space domain awareness" Progress in Aerospace Sciences. 147 (2024): 101019; p. 3
[17] M. J. Holzinger, et.al. A Primer on Cislunar Space. Air Force Research Laboratory, 2021, (Link), p. 5

Communications. Although they are important to both actions in orbit *and* on the lunar surface, this report will focus only on PNT and Communications issues that are particularly relevant for SSA and STM. Those include the **lack of a coordinated time reference, the lack of uniform spatial reference schemes, and potential congestion of ground stations.** On the Communications infrastructure side, the Earth-based ground stations are already facing access issues as more and more spacecraft are launched into cislunar orbits and beyond.[18] Yet, maintaining consistent custody of and communication with spacecraft in cislunar space is critical to ensure proper orbit maintenance and communicate needed manoeuvres — two factors that will only grow in importance as collision risks in lunar orbits grow. Thus, **enhancing communication capabilities via both Earth-based and space-based infrastructure will become key in ensuring cislunar safety**.

Considering the challenging cislunar orbital dynamics and collision risks, **enhancing SSA and STM, including addressing relevant PNT and Communications issues, will be essential for ensuring the safety of assets and astronauts in cislunar orbits**.

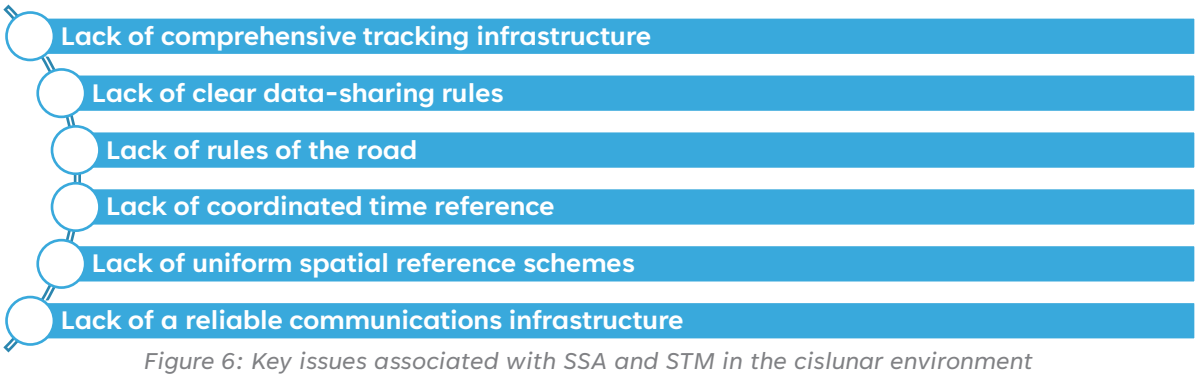

Figure 6: Key issues associated with SSA and STM in the cislunar environment

3.2.2 Space Debris and End-of-Life

Researchers estimate that there are currently around 200 large pieces of debris orbiting the Moon — though the precise number is elusive due to both the tracking issues described in the previous section and the fact that, until recently, there was little need to map lunar debris.[19] **Yet, as the number of missions to lunar orbits grows, so does the possibility of more debris creation, which poses safety risks to both spacecraft and astronauts**.

Debris around the Moon can be crudely divided into two types — natural and human-made**. Natural debris** mostly comprises the ejecta — plumes of pulverised rock and regolith particles — resulting from objects impacting the lunar surface, be it from meteoroid impacts, objects crashing from unstable orbits, or landings on the lunar surface. This ejecta can spread sideways, creating more craters on impact, or shoot upwards, reaching escape velocity and hitting spacecraft above. Though spacecraft stationed in higher orbits, like the Lunar Gateway, will be unlikely to suffer much damage, orbiters stationed at altitudes similar to those of Apollo command modules could receive hundreds of millions of impacts per square meter.[20]

On the human-made debris side, the key issue is rising collision risks between spacecraft.[21] Beyond spacecraft collisions, spent upper stages used to propel spacecraft into lunar orbits add

[18] Jeff Foust, "Increasing demands putting pressure on Deep Space Network" *SpaceNews.* , 10 Jul. 2021, (Link); Jeff Foust, "NASA Deep Space Network reaches 'critical point' as demand grows" *SpaceNews.* , 29 Aug. 2023, (Link)
[19] Vishnu Reddy, "More lunar missions means more space junk around the Moon" *The Conversation*, 6 Feb. 2023, (Link)
[20] Philip T. Metzger and James G. Mantovani, "The Damage to Lunar Orbiting Spacecraft Caused by the Ejecta of Lunar Landers" in *Earth and Space 2021.* (American Society of Civil Engineers, 2021), 136–145. (Link); M M Wittal and R J Power, "Spaceflight Hazards of Escape-Velocity-Domain Impact Ejecta in the CR3BP" *AAS/AIAA Astrodynamics Specialist Conference.* (2019), (Link); Lewis Dartnell, "Lunar dust ejecta could create problems for future crewed Moon missions" *BBC Sky at Night Magazine.* , 15 Jul. 2023 (Link); William Steigerwald, "Camera on NASA's Lunar Orbiter Survived 2014 Meteoroid Hit - NASA" *NASA.* , 26 May 2017, (Link)
[21] Vishnu Reddy, "More lunar missions means more space junk around the Moon" *The Conversation*, 6 Feb. 2023, (Link)

further uncertainty to the debris environment.[22] Human-made debris can also get "trapped" in the more stable regions in the Earth-Moon system, particularly around L4 and L5, reducing the usability of those regions for future missions.[23] The issue is further exacerbated by **the lack of universal end-of-life procedures for objects in cislunar orbits**: historically, they have been most often disposed of by being crashed into the lunar surface, but such disposal practices create ejecta that can endanger astronauts as well as still operational spacecraft.[24]

Considering the instability of the cislunar environment, the proliferation of debris around the Moon would pose a potentially larger threat to cislunar spacecraft and astronauts than it does to the assets in Earth orbits. Therefore, **concerted mitigation and remediation efforts will be essential to ensure the long-term safety of astronauts and the viability of assets stationed around the Moon.**

Figure 7: Key issues associated with Debris and End-of-Life in the cislunar environment

3.2.3 Space Weather

With the Moon lacking a magnetic field and atmosphere, space weather poses higher safety risks in the cislunar environment than near Earth.[25] At least one lunar orbiter has already been damaged by SW in this century — India's Chandrayaan-1, whose star trackers reportedly failed due to excessive radiation.[26] Astronauts on lunar missions are also likely to receive a daily radiation dose that is 2.6 times higher than that received by astronauts on the International Space Station.[27] Yet, while there has been an uptick in dedicated instruments and payloads studying SWE generally, **long-term Space Weather impacts in the cislunar environment remain understudied**, as research has long focused mostly on impacts around the Earth.[28] Further research into the subject is thus urgently needed to ensure long-term spacecraft viability and astronaut health in the cislunar environment.

Similarly, **better SWE forecasting techniques will be required to ensure infrastructure and astronaut safety.** Currently, alerts for SWEs are often issued *after* the first solar flares or coronal mass ejections are detected, giving stakeholders less than an hour to prepare. Existing techniques also cannot always precisely forecast the severity of an event, despite that being an important factor in formulating a response.[29] Considering the potential harm SWEs can cause to both spacecraft and astronauts, **understanding and properly mitigating such events will be critical to ensure uninterrupted operations and astronaut safety around the Moon.**

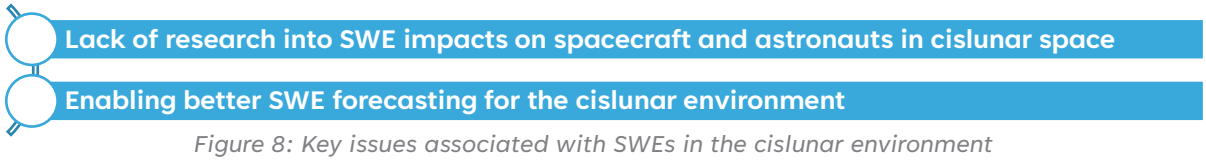

Figure 8: Key issues associated with SWEs in the cislunar environment

[22] ESA, "Incoming! Debris enroute to the Moon" *ESA.* , 2 Feb. 2022, (Link); Tricia Talbert, "'WT1190F' Safely Reenters Earth's Atmosphere, Provides Research Opportunity " *NASA.* , 14 Nov. 2015, (Link)
[23] Brian Baker-McEvilly et al., "A comprehensive review on Cislunar expansion and space domain awareness" Progress in Aerospace Sciences. 147 (2024): 101019; p. 21
[24] Nathan R Boone and Robert A Bettinger, "Efficient disposal of low lunar orbiters on the lunar surface" *Journal of Space Safety Engineering*. (2024), (Link)
[25] ESA, "Space Safety for the Moon," 31 Oct. 2024, (Link)
[26] Divya Gandhi, "Chandrayaan's first sensor failed much earlier" *The Hindu.* , 19 Jul. 2009, (Link)
[27] Katie Hunt, "Radiation on moon's surface measured for the first time, study says" *CNN.* , 25 Sep. 2020 (Link)
[28] Anna Fogtman et al., "Towards sustainable human space exploration" *npj Microgravity*. 9.1 (2023) (Link).
[29] Lulu Zhao, "Space weather forecasting needs an upgrade to protect future Artemis astronauts" *The Conversation*, 13 Jun. 2024 (Link); Neel V. Patel, "How space weather could wreck NASA's return to the moon" *MIT Technology Review*, 20 May 2021, (Link)

4 OVERVIEW OF EXISTING POLICY PROVISIONS AND PROGRAMMATIC DEVELOPMENTS IN CISLUNAR SAFETY AND SUSTAINABILITY

The following chapter presents a broad overview and analysis of existing programmatic developments and policy positions on cislunar safety and sustainability across the 36 analysed countries and ESA. The findings highlight that in both programmes and policy discourse, the focus on safety, while generally present, has been uneven, often overshadowed by other policy considerations and interests.

4.1 Programmatic Developments in Cislunar Safety

Beyond the 36 analysed countries, this section also includes missions run by ESA, as many European countries engage in lunar activities through ESA missions. Missions and projects included those launched and announced between 2018 and the end of February 2025. More information on the Methodology is available in Annex B.

Both past and future missions incorporate various components relevant to the three identified technical challenges — SSA (including PNT and Communications), space debris, and space weather (SW). **Yet, the number of such components remains low compared with the overall number of lunar missions and payloads. The focus of such components is also uneven**, with most attention being paid to SW — particularly to radiation measurements — and the PNT and communications subcomponents of SSA. **The number of components related to object tracking itself and debris mitigation remains low in the programmatic landscape.**

Missions that have already been launched included at least 32 payloads relevant for the three identified technical challenges (see Figure 9). Half of them comprised payloads for studying various components of SW, including the radiation environment around the Moon, while less than 10% focused on investigating cislunar debris. Fourteen payloads were relevant for SSA considerations, though when that component is broken down into payloads more relevant for Surveillance and Tracking, PNT or Communications, the numbers show that all of them primarily focused on the PNT and Communications subcomponents, and not on object tracking.

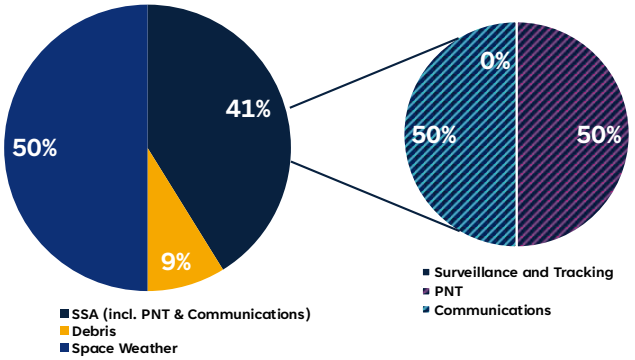

Figure 9: Category split of safety-relevant payloads of launched lunar missions

Most of the identified relevant payloads were created by the U.S., but seven also came from European actors, including Germany, Finland, Italy, Sweden, and the Netherlands (see Figure 10). Examples

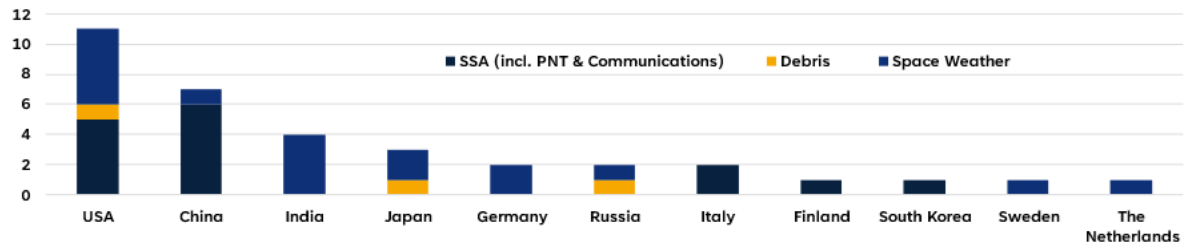

Figure 10: Number and type of safety components countries have contributed to

include the Netherlands-China Low Frequency Explorer used to study SW, launched on China's Chang'e 4 mission, as well as NASA-ASI's Lunar GNSS Receiver Experiment (LuGRE) from Blue Ghost Mission 1, which demonstrated the usage of GNSS signals for navigation on and around the Moon. [30]

Beyond payloads on launched missions, some existing infrastructure and processes on Earth have been helping ensure safety in the cislunar environment. Aside from various ground stations that can be used to track objects and existing general SW research and forecasting facilities, they include programmes like NASA's Multimission Automated Deepspace Conjunction Assessment Process (MADCAP) whereby actors with spacecraft outside of Earth orbits can voluntarily provide their spacecraft ephemerides to NASA and have NASA screen them for potential future collisions. [31] Still, as mentioned before, Earth-based efforts are not entirely sufficient to ensure safety in cislunar space.

Looking into the future, **out of the over 180 lunar projects in development that were identified for this report, around 50 are relevant for the three identified technical challenges.** Split across the three technical categories, they show that the focus is shifting slightly away from SW concerns toward those relevant for SSA (see Figure 11). In line with the trend observed on launched missions, however, most projects in the SSA category focus on PNT and communications, rather than object tracking.

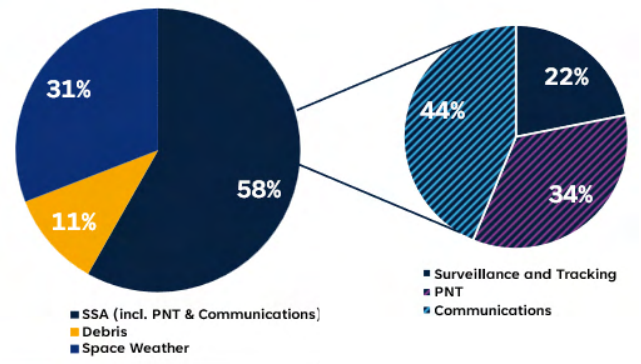

Figure 11: Category split of planned and ongoing safety-relevant projects

Still, **there is a noticeable increase in tracking-related projects**, now comprising 22% of the entire SSA category. **The uptick comes mostly from U.S. missions** like Oracle — a planned satellite that will be used to detect and track objects in cislunar space, currently scheduled to launch in 2027. [32] Therefore, the focus on SSA is starting to gradually expand through an interest in object tracking itself.

The planned projects also include more European contributions than those that have already been launched. **At least 15 ongoing safety-relevant projects come from Europe**, with at least 11 European countries working on them. In line with the general trend, the European contributions focus mostly on projects relevant for PNT, communications, and SW, followed by space debris, and surveillance and tracking (see Figure 12).

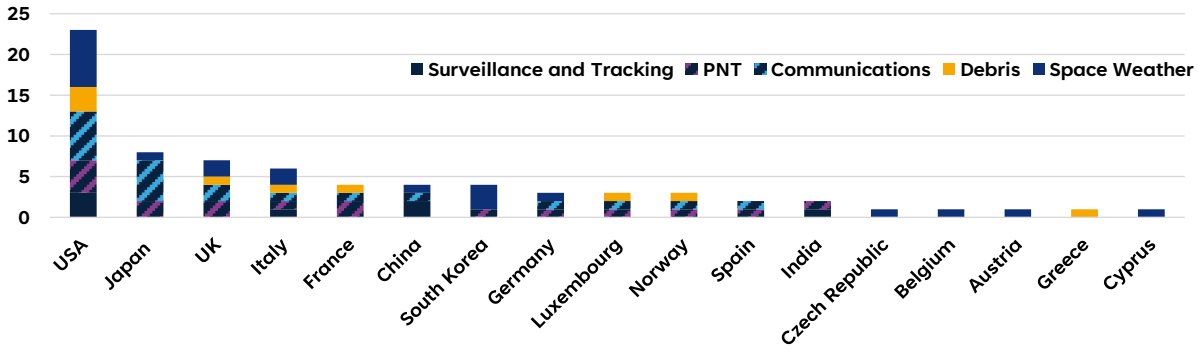

Figure 12: Number and type of safety projects countries are contributing to

[30] Radboud Universiteit, "Netherlands-China Low-Frequency Explorer (NCLE) | Radboud University," 2023, (Link); Katherine Schauer, "NASA Successfully Acquires GPS Signals on Moon - NASA" *NASA.* , 4 Mar. 2025, (Link)
[31] NASA, "Multimission Automated Deepspace Conjunction Assessment Process (MADCAP) - NASA," 2 Aug. 2022, (Link)
[32] Advanced Space, "Oracle | Advanced Space," 25 Nov. 2024, (Link)

The increase in European contributions comes primarily from several projects planned by ESA, such as the Moonlight programme for comprehensive cislunar PNT and communications infrastructure.[33] Beyond contributions to ESA's missions, projects include activities such as a study on post-mission disposal in cislunar space funded by the UK Space Agency (UKSA) and the enhancements to ASI's Deep Space Antenna in Sardinia to help better support national and international cislunar missions.[34]

Overall, while the planned safety-relevant projects in Europe and foreign countries highlight a noteworthy increase in both topical and territorial diversity compared with past pursuits, **the safety focus largely remains on what may be perceived by actors as more "immediate" infrastructure and research concerns in preparation for future missions, rather than long-term considerations.** Those immediate concerns include the need to ensure consistent communication, navigation and protection from SWEs. Still, **as both the U.S. and China increasingly consider the potential security implications of operations in cislunar space, the focus is gradually expanding toward including more comprehensive SSA issues** — though experts disagree on whether cislunar currently holds any value for security considerations.[35]

4.2 Analysis of Existing European and international Policy Positions

Moving beyond purely programmatic developments, the following subchapter assesses how cislunar safety and lunar exploration feature in statements and policy documents produced by the selected actors. Though concerns about the identified technical **safety issues are growing** in importance, they **remain secondary to other goals in lunar pursuits**, as highlighted by the fact that less than a third of identified planned projects are focusing on SSA and STM-related activities (incl. PNT and Communications), debris and end-of-life, and space weather. Ultimately, safety and sustainability issues in lunar exploration most often become relevant only if nations are considering going to the Moon to begin with. Thus, **clarifying the broader policy objectives that actors pursue via lunar exploration and the means they pursue them with is a critical step in elucidating why they may also consider working on cislunar safety**.

In line with this thinking, this chapter focuses not only on mentions of the topics relevant to the safety considerations described in Chapter 3, but also on the intersections between lunar exploration and broader space policy objectives and means of achieving them across three groups of statements and documents:

National Policies and Strategies | **Multilateral Policies and Strategies** | **Statements at United Nations Forums**

4.2.1 Analysis of European and International Policy and Strategy Documents

Countries and actors primarily outline their cislunar priorities in both national and multilateral policies and strategies. **The following section presents an analysis of over 100 such documents to clarify stated objectives in lunar exploration and cislunar safety.** Though countries clarify their space ambitions through various means, including parliamentary hearings, cross-sectoral policies and other documents, **the authors analysed only the broad national space-specific policies and strategies for consistency across the sample.**

[33] European Space Agency, "ESA launches Moonlight to establish lunar communications and navigation infrastructure," 15 Oct. 2024, (Link)
[34] Telespazio, "The Italian Space Agency has awarded Telespazio a contract for upgrading the Sardinia Deep Space Antenna," 4 Oct. 2024, (Link)
[35] Robert S. Wilson, Bleddyn Bowen, and Namrata Goswami, *HIGH GROUND OR HIGH FANTASY: DEFENSE UTILITY OF CISLUNAR SPACE* (Aerospace Center for Space Policy and Strategy, May 2024), (Link); Clayton Swope and Louis Gleason, *Salmon Swimming Upstream: Charting a Course in Cislunar Space* (CSIS, October 2024), (Link), p.2

Both European and non-European actors analysed in this study have produced dozens of national space policies and strategies guiding their lunar exploration efforts. The criteria-based analysis highlights both areas of commonalities between European and non-European actors, such as a focus on commercialisation and international collaboration, and divergencies, such as an interest in norm-setting and international leadership that is more prevalent outside of Europe. The actors' contributions to multilateral documents further underscore an interest in international collaboration and norm-setting.

European National Policy and Strategy Documents

This sub-chapter focuses on the analysis of the latest national space policy and strategy documents within the 30 analysed European states. The full methodology is available in Annex B.

Out of 30 European countries analysed, only 26 have dedicated national space policies and strategies, with 47 documents in total. **Just 14 of those countries have referenced lunar topics in their national documents** (see Figure 13). As more than 14 European countries are working on lunar projects and have mentioned an interest in lunar issues at the UN, the **difference highlights a mismatch between programmatic and international action and national space strategy elaboration** in some European countries. **It could also, however, be the consequence of those countries mostly working with ESA on exploration as opposed to nationally.**

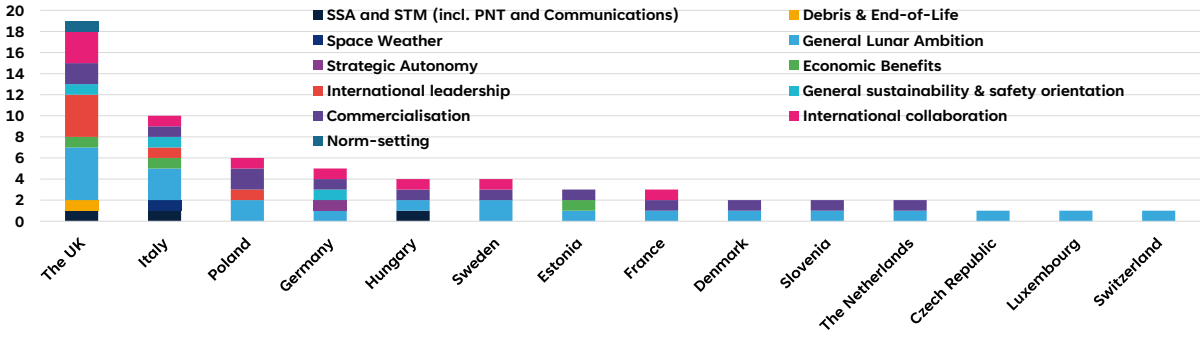

Figure 13: Mentions of lunar issues in European national space policies and strategies

All 14 countries have mentioned at least a general interest in lunar exploration, with 21 of the documents broadly outlining their pursuits. **The UK emerges as the country with the most mentions** of lunar-relevant topics in its documents, followed by Italy, Poland and Germany — though it is important to note that the number of space policies a country has produced also impacts the total count of mentions. Despite its high level of contributions to projects and statements at the UN, France only ties for the sixth spot in this breakdown — likely because its most relevant formal national space policy document was last updated over half a decade ago in 2019.[36] It is expected that its lunar ambitions will feature more prominently in its new space strategy, slated to come out sometime in 2025.[37] **Most of the identified references do not address cislunar safety, but rather innovation, economic opportunities, cooperation, and scientific returns.**

Actor Spotlight: The United Kingdom

The UK presents one of the most comprehensive outlooks on lunar exploration in its national space documents. Mentioning topics relevant to 9 out of 11 analysis criteria, **its policies and strategies highlight an understanding of lunar exploration as synergistic with a variety of other space policy concerns,** from international leadership to commercialisation. While the country aligns with other

[36] Armed Forces Ministry, *Space Defence Strategy*, France's Armed Forces Ministry, 2018 (Link)
[37] Le Monde and AFP, "François Bayrou lance une mission pour une 'stratégie spatiale nationale' à l'horizon de 2040" (Le Monde, 7 Mar. 2025), (Link)

European actors on most policy priorities, one topic sets it apart from the rest: **the UK seems to be the only European country whose national policy documents indicate an explicit interest in regulatory norm-setting in cislunar space.**

In its *Space Regulatory Review 2024,* the country contends that the UK "*must play an active role in shaping the developing norms and regulatory policy of the burgeoning lunar economy*" to ensure that it can capitalise on this economy's benefits. As the first lunar mission built by a UK company — ESA's Lunar Pathfinder manufactured by Surrey Satellite Technology Ltd — is preparing for launch, **the country is already working on a national law dedicated specifically to the safety and sustainability of cislunar activities to ensure UK companies pursue lunar missions responsibly.** Such a framework will serve to "*give regulatory clarity for UK industry to participate in the emerging lunar economy*", as well as to preserve the lunar environment for future generations. Key lunar sustainability challenges the UK identifies for this regulation include "*end of mission disposal, lunar science preservation, and … operat[ing] in an increasingly crowded lunar environment*" — with two of them aligning with key technical issues outlined in this report, namely space debris and end-of-life and SSA and STM. [38]

Beyond establishing certainty for national actors, the country intends to utilise the forthcoming law in its regulatory diplomacy pursuits, particularly within UN frameworks such as the Action Team on Lunar Activities Consultation (ATLAC). The goal of such diplomacy is to ensure that there is an ongoing conversation on lunar safety and sustainability topics and that the lunar environment remains safe and predictable for both the UK and other actors.

Commercialisation emerges as a key interest, with 13 documents across 11 countries highlighting how lunar exploration can help their national space industries. For example, Denmark states that its Máni Mission "*will support innovation and growth in the Danish business sector*", while Germany underscores that participation in lunar missions opens opportunities for its Small and Medium-sized Enterprises. [39] **Eight of the documents across seven countries also underscore the importance of international collaboration** for European nations in their lunar pursuits. France's National Centre for Space Studies (CNES), for instance, underscores its international interests, stating that CNES "*helps structure cooperation and thus optimise French scientific returns*", including in ongoing and future lunar missions with ESA, the U.S., and China. [40] **Like CNES, many European actors also still highlight science and research as a key interest in pursuing lunar missions, though interests in industry growth and emerging lunar markets are significant.** Twelve

Figure 14: ESA & EU Member States mentioning science in the context of lunar pursuits

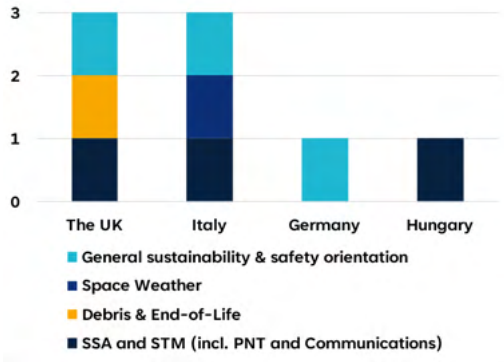

Figure 15: Mentions of safety- and sustainability- relevant issues in European policies and strategies

[38] Department for Science, Innovation and Technology, *Space Regulatory Review 2024*, 2024, (Link), pp. 13, 17, 18
[39] Ministry of Higher Education and Science Denmark, "Strategy for space research and innovation" UFM.dk. , Nov. 2024, (Link), p. 19; Federal Ministry for Economic Affairs and Climate Action, "The German Federal Government's Space Strategy" *BMWK.* , Sep. 2023, (Link), p. 53
[40] Centre national d'études spatiales, *Contrat D'objectifs Et De Performance État- Cnes | 2022 - 2025: Nouveaux Espaces CNES.* , September 2022, (Link), p. 20

national documents across nine countries include scientific considerations in the context of the countries' lunar pursuits (see Figure 14).

While the documents highlight many policy priorities, their discussion of cislunar safety and sustainability issues is lacklustre. Just three documents from three countries discuss topics relevant to the key safety issues identified as the focus of this study, and only three countries have made broader statements about the need to pursue lunar exploration in a safe and sustainable manner (see Figure 15). **Other least-mentioned concerns include international leadership, strategic autonomy, and norm-setting.**

Actor Spotlight: Italy

Italy's documents present one of the most consistent commitments in Europe to lunar exploration and **underscore a high level of synergies between its programmatic developments and policy pursuits, including an interest in independent missions. It is also one of the few countries that has used the EU's Recovery and Resilience Funds to fuel its lunar ambition**, highlighting the flexibility the funding instrument has offered its users to pursue projects in the space sector. Italy's documents highlight that the country plans to "*strengthen [its] space leadership*", not least through lunar exploration.[41] Other goals include SSA and STM through the contributions of Italy's Deep Space Antenna.[42]

On the programmatic side, **the country is pursuing several projects aligning with the stated goals and more.** On SSA and STM, it has invested in upgrades to the Sardinia Deep Space Antenna "*to strengthen the Italian role in the Artemis and other international lunar programs*".[43] **The upgrades came under the country's Earth-Moon-Mars programme that saw Recovery and Resilience Funds used for further lunar exploration pursuits**, including preliminary studies for infrastructure on lunar soil.[44] Crucially, in its aim to secure a leading position in space, **Italy remains one of just a few European countries with current plans for an independent lunar mission.** In 2024, the country awarded OHB Italia over €1M for a study dedicated to a future Robotic Mission to the lunar surface.[45]

Since most European countries participate in lunar exploration via ESA, the Agency's priorities also critically impact Europe's approaches to cislunar safety. ESA's lunar pursuits are guided by five strategies and guidelines that underscore the importance of cislunar safety for the Agency (see Figure 16).

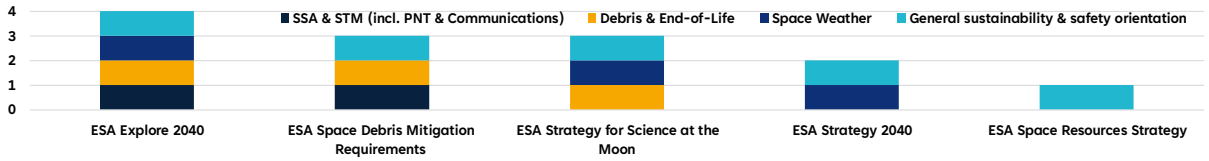

Figure 16: Mentions of safety- and sustainability- relevant issues in ESA's strategies

On SSA and STM (including PNT and Communications), considerations explicitly relevant for tracking and STM are emerging, with ESA's *Explore 2040* strategy calling "*matured Cislunar Space Traffic Management technology*" one of the potential enablers of future exploration of the solar system beyond the Moon, and ESA's *Space Debris Mitigation Guidelines* including a

[41] Presidency of the Council of Ministers, *Government guidelines on space and aerospace*, January 14, 2025, (Link), p. 9
[42] Italian Space Agency, *DOCUMENTO DI VISIONE STRATEGICA PER LO SPAZIO 2020 -2029* (ASI, 2020), (Link)
[43] Ministry of Universities and Research, *EARTH-MOON-MARS*, (Link)
[44] ASI, "EARTH, MOON, MARS (EMM)" *ASI*. (Link)
[45] Italian Space Agency, "2024-26-I.0 'Phase A Study for the Robotic Mission to the Lunar Surface'- OHB Italia" *Portale Trasparenza*., 2024, (Link)

subsection on Space Traffic Coordination in lunar orbits.[46] **Space debris and end-of-life issues are also highlighted** as critical concerns, with ESA's latest debris mitigation guidelines including dedicated subsections on the disposal of lunar spacecraft and avoiding the creation of cislunar space debris.[47] **On SW**, documents like *Explore 2040* call for "*efficient synergies*" on SW research across various exploration destinations.[48]

Non-European National Policy and Strategy Documents

This sub-chapter focuses on the analysis of the latest national space policy and strategy documents within the six non-European states. The full methodology is available in Annex B.

Outside of Europe, all analysed countries but one — namely, the U.S., Japan, South Korea, China and Russia — mention lunar pursuits in their 55 identified policy and strategy documents (see Figure 17). **Despite India's prominence in lunar programmes, its space policies and strategies focus only on space exploration broadly**, without any discussions dedicated to lunar exploration specifically, excluding it from the overarching analysis. Still, some of its other documents, like the questions posed to the government by the Parliament confirm a strong interest in crewed lunar exploration and moon sample collection.[49]

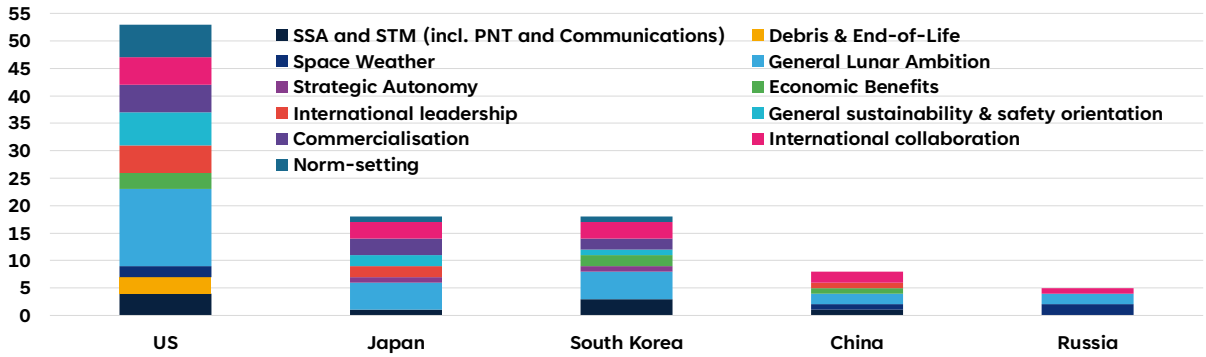

Figure 17: Mentions of lunar issues in non-European national space policies and strategies

The U.S. emerges at the top of the list of various cislunar mentions in its documents, followed by Japan and South Korea. Like for European actors, a focus on international collaboration features prominently in the documents, with 13 policies and strategies across five countries mentioning the topic. Commercialisation also emerges as a key interest, with five documents across three countries mentioning relevant topics. Japan, for instance, underscores that its participation in the Artemis programme "*creates business opportunities for industries including those formerly less-related to space*".[50] **Scientific pursuits are also critical for non-European nations, with five of them touching on scientific priorities in lunar exploration in their documents.** Four of them — the U.S., Russia, China, and South Korea — have produced dedicated strategies focused on the science side of space exploration that include lunar and cislunar concerns, while Japan has noted that its lunar exploration activities "*will contribute to the acquisition of scientific results*".[51]

[46] European Space Agency, *Explore 2040: The European Exploration Strategy*, October 2024, (Link), p. 18; ESA Space Debris Mitigation Working Group, *ESA Space Debris Mitigation Requirements*, October 2023, (Link), p. 53
[47] ESA Space Debris Mitigation Working Group, *ESA Space Debris Mitigation Requirements*, October 2023, (Link), pp. 52-53
[48] European Space Agency, *Explore 2040: The European Exploration Strategy*, October 2024, (Link), p. 18
[49] Council of States, *GOVERNMENT OF INDIA DEPARTMENT OF SPACE RAJYA SABHA UNSTARRED QUESTION NO. 2852*, December 19, 2024, (Link)
[50] Strategic Headquarters for National Space Policy, *Policy of Japan on the Participation in International Space Exploration under the Proposal of the United States*, October 18, 2019, (Link), p. 1
[51] National Space Science Center, *National Mid- and Long-term Plan for Space Science in China (2024-2050) NSSC.* , 2024, (Link); Korean AeroSpace Administration, *Strategy for Promoting Space Science Exploration in Korea* , February 25, 2025, (Link); National Science and Technology Council, *National Cislunar Science and*

Despite these similarities between European and non-European priorities, notable differences in their approaches remain. While in Europe, only the UK mentioned topics relevant to broader international norm-setting as relevant for its lunar pursuits, **three non-European actors — the U.S., Japan, and South Korea — include statements on setting international norms and standards in their documents. Japan and South Korea also highlight a focus on another aspect that in Europe was only mentioned by Germany — strategic autonomy in relation to lunar pursuits. International leadership is also a more common concern among non-European states,** with over half of them mentioning relevant statements in their documents, while in Europe only around 10% of the countries expressed an interest in the subject.

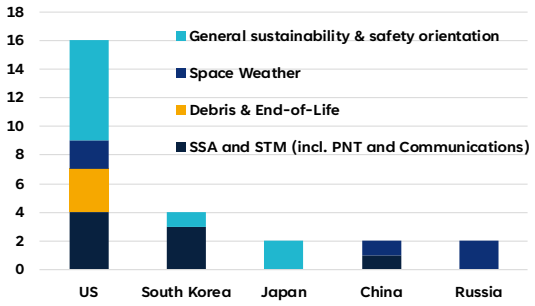

Figure 18: Mentions of safety- and sustainability-relevant issues in non-European documents

Another key difference is **the focus of non-European countries on safety and sustainability in cislunar space.** Four countries have mentioned topics related to the three key safety challenges identified in this report, and three of them have highlighted their general interest in sustainable approaches to lunar exploration (see Figure 18).

While the focus within SSA and STM has largely remained on PNT and Communications, **an interest in tracking and observation is emerging.** In its documents, South Korea has announced its plans to build a satellite "*for observation of the space between the Earth and the Moon*", and the U.S. has tasked national actors with "*extend[ing] U.S. space situational awareness capabilities into Cislunar space*". [52] **On debris and end-of-life**, the U.S. government has committed to "*preserv[ing] a safe and sustainable environment in Cislunar space—such as limiting debris in Lunar orbit*". [53] On **SW, the U.S., Russia, and China have all highlighted research on the subject as a priority area in their exploration pursuits**. [54]

Overall, while there are many similarities in the European and non-European countries' understandings of their lunar efforts, **the non-European countries, on average, have a more evenly distributed focus among various priorities**. The U.S., Japan, South Korea, and China have all mentioned lunar topics in connection with more than half of the Policy and Safety Criteria identified for this study. In Europe, only the UK and Italy have ranked that highly, with other countries focusing on at most five identified criteria in connection with their lunar exploration interests.

Actor Spotlight: The United States

Out of all the actors analysed in this report, the U.S. has been the most prolific in its national space policy articulation, with over 30 various policies, strategies and executive orders released during President Donald Trump's first term and during President Joe Biden's time in office. Over two-thirds of these documents mentioned priorities related to lunar exploration, **with the U.S. emerging as the actor most comprehensively addressing all three identified technical safety issues and challenges in its policies and strategies.**

Technology Strategy, November 2022, (Link); Russian Academy of Sciences, *Focus Of Scientific And Technological Research In Accordance With The Concept Of Exploration And Development Of The Moon*, 2020, (Link); JAXA, *JAXA's Space Exploration Roadmap*, 2019, (Link)

[52] Korea AeroSpace Administration, *Aerospace Administration Policy Direction* (KASA, 2024), (Link), p. 13; National Science and Technology Council, *National Cislunar Science and Technology Strategy*, November 2022, (Link), p. 11

[53] National Science and Technology Council, *National Cislunar Science and Technology Strategy*, November 2022, (Link), p. 11

[54] NASA, Moon to Mars Objectives, September 2022, (Link), p. 6; National Space Science Center, *National Mid- and Long-term Plan for Space Science in China (2024-2050) NSSC.* , 2024, (Link); Russian Federal Government, *Main Provisions Of The Fundamentals Of State Policy Of The Russian Federation In The Field Of Space Activities For The Period Up To 2030 And Beyond*, 2013, (Link), p. 2

The National Cislunar Science & Technology Strategy (2022) — the only document in analysed countries dedicated purely to cislunar space — includes the need to establish cislunar SSA capabilities, mitigate debris in the environment, and implement cislunar PNT and communications infrastructures, with a focus on interoperability of such technologies with those of commercial and international partners. It also suggests that new activities in cislunar space should be coordinated with ongoing research streams on topics such as SW.[55] In 2024, the S&T Strategy was supplemented by the *National Cislunar Science and Technology Action Plan,* which tasked NASA and the Department of Defence with, among other things, "*increasing cooperation and data-exchanges with other users of cislunar space*" and "*developing procedures for publicly sharing cislunar SSA data*" to support both SSA and STM efforts.[56] In the same year, the Office of Science and Technology Policy also released two memos — one on Celestial Time Standardisation and one on Lunar Reference Systems. The memos task NASA and other relevant U.S. actors with both establishing and promoting a U.S. approach to lunar time and frames of reference among international actors by 2026 to ensure a unified framework for lunar actors.[57]

Despite these past lunar efforts, however, **it remains to be seen whether lunar exploration and safety will remain a priority during President Trump's second term**. **The proposed budget for NASA** for fiscal year 2026 — which is still pending approval by Congress —**plans for the cancellation and phaseout of key Artemis programme components, such as the Lunar Gateway and the Orion capsule.** Considering massive amounts of funding that foreign partners have already invested into the projects slated to be cut — such as ESA's contributions to Gateway and Orion — **if US funding cuts go through, they may present both a threat and an opportunity for Artemis partners' lunar pursuits.** Potential solutions to the funding cuts suggested by experts have ranged from ESA needing to take the full leading role on the projects to the creation of a truly multilateral consortium of former Gateway partners, such as ESA, Canada, Japan and the United Arab Emirates.[58]

4.2.2 Analysis of Multilateral Policy and Strategy Documents

This sub-chapter focuses on the analysis of various binding and non-binding multilateral instruments that apply to lunar exploration. Only documents produced by groups, forums and entities with participation of governments or space agencies of the analysed countries are included. The full methodology is available in Annex B.

National pursuits in space exploration in general, and lunar exploration in particular, are guided by several longstanding international laws and treaties, as well as by more recent international documents outlining various actors' joint goals and means of achieving them. Thus, assessing such multilateral documents is crucial to clarify the international community's concerns and priorities in cislunar safety.

At the treaty level**,** all **five main UN documents guiding space activities** apply to activities in cislunar space**.** Yet, as the treaties were written at a time before intense lunar exploration was possible, they largely do not account for various issues stemming from the challenges of the cislunar

[55] National Science and Technology Council, *National Cislunar Science and Technology Strategy*, November 2022, (Link)
[56] National Science and Technology Council, *National Cislunar Science and Technology Action Plan*, December 2024, (Link), p. 6
[57] Office of Science and Technology Policy, *Policy on Celestial Time Standardization in Support of the National Cislunar Science and Technology (S&T) Strategy The White House.* , April 2, 2024, (Link); Office of Science and Technology Policy, *Policy on Standardization of Lunar Reference Systems in Support of the National Cislunar Science & Technology Strategy The White House.* , December 18, 2024, (Link)
[58] Emma Gatti and Andrea D'Ottavio, "Artemis Cuts: An Analysis for Europe" *The Space Republic.* , 26 May 2025, (Link)

environment. **Thus, various non-binding international policy documents are also becoming key instruments for actors to clarify their joint positions on cislunar safety and goals for lunar exploration.** Seven such documents that already include lunar concerns have been identified for the selected actors in this study.

Document	Initiator	Brief Description	Possible Participants
Global Exploration Roadmap (2011; last updated in 2024)	International Space Exploration Coordination Group (ISECG)	A consensus-based document reflecting ISECG members' coordinated vision for long-term human and robotic exploration of the solar system.	Space agencies
International Deep Space Interoperability Standards (2019; last updated in 2024)	NASA, JAXA, ESA, Canadian Space Agency (CSA)	A set of nine documents outlining international interoperability standards to facilitate cooperative deep space exploration, including lunar exploration. Includes standards on Avionics, Communications, Docking, Environmental Control and Life Support Systems, Power, Rendezvous, Robotics, Thermal, and Software.	Space agencies
Artemis Accords (2020)	U.S. Government	A set of principles to guide signatories' civil space exploration, particularly for those participating in the U.S.'s Artemis programme.	Countries worldwide
Committee on Space Research (COSPAR) Policy on Planetary Protection (2020; last updated in 2024)	Space Agencies, academia	A document with guidelines and standards on avoiding organic and biological contamination in space exploration, including on the Moon.	Space agencies, academia
UN COPUOS Guidelines for Long-Term Sustainability of Outer Space Activities (2021)	UN	Voluntary measures for ensuring the safety and sustainability of outer space activities. Includes some references to activities "beyond" Earth orbits.	Countries worldwide
International Lunar Research Station (ILRS) Guide for Partnership (2021)	China's Government	Guidelines for participation in China's ILRS programme.	Countries worldwide
LunaNet Interoperability Specifications (2025)	NASA, JAXA, ESA	A set of documents for mutually agreed-upon standards and protocols to enable PNT and communications interoperability on the Moon.	Space agencies

Table 2: Relevant international policy documents

The documents largely fall into two groups: technical policies and guidelines, and broader exploration principles and strategies.

Four of the documents outline concerns related to the three identified safety challenges, with three mentioning topics related to cislunar SSA and STM (including PNT and communications), two highlighting concerns about debris and end-of-life, and one mentioning subjects relevant to SW (see Figure 19). **The prominence of these topics in international documents underscores the importance of these subjects for actors engaging in lunar exploration and their emerging commitment to addressing these issues in international settings.**

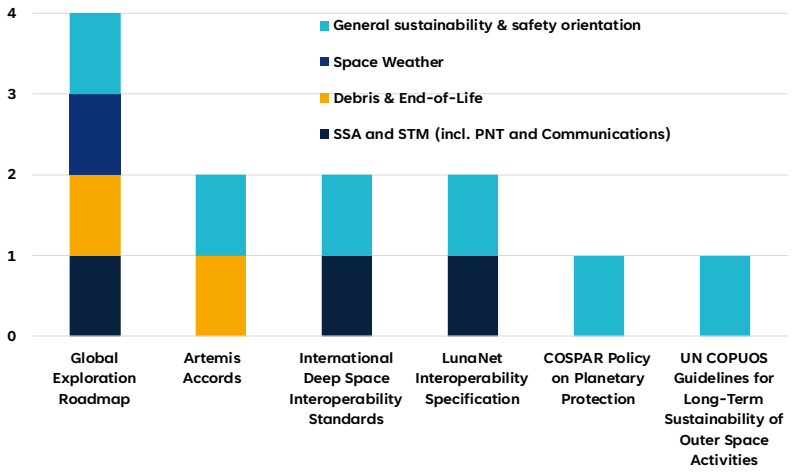

Figure 19: Mentions of safety- and sustainability-relevant issues in multilateral documents

On SSA and STM (including PNT and Communications), several documents, such as LunaNet Standards, International Deep Space Interoperability Standards, and the Global Exploration Roadmap, focus largely on PNT and communications issues and the need to ensure the existence and the interoperability of relevant infrastructure. **Space debris and end-of-life issues are also highlighted** as critical concerns, with documents like the Artemis Accords dedicating an entire section to orbital debris, making its signatories commit "*to plan for the mitigation of orbital debris, including the safe, timely, and efficient passivation and disposal of spacecraft at the end of their missions*" and to prevent introduction of new harmful debris to the cislunar environment.[59] **On SW**, documents like the Global Exploration Roadmap underscore the topic and its subsets, such as radiation, as priority investigation areas.[60]

Beyond discussions relevant to the specific identified safety concerns, **all of the documents also highlight policy considerations** relevant to the authors' and participants' lunar exploration pursuits (see Figure 20). **General sustainability and safety emerge as the key priority for actors,** with six of the documents mentioning the topic in some way. **China's document for partners in its ILRS project is the only exception, making no**

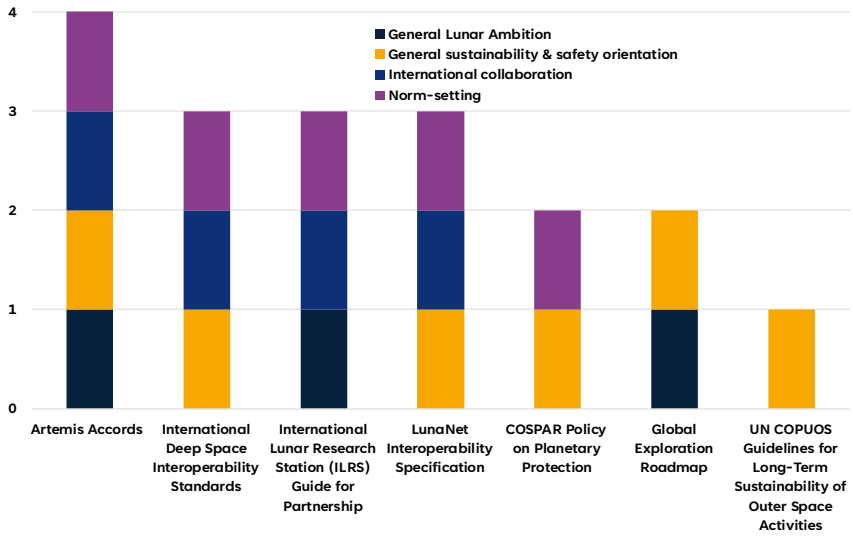

Figure 20: Mentions of policy-relevant issues in multilateral documents

[59] U.S. Government, *The Artemis Accords*, 2020, (Link), section 12.
[60] The International Space Exploration Coordination Group, *Global Exploration Roadmap*, 2024, (Link), pp. 32, 24, 38, 45

mention of any safety or sustainability concerns. Six documents also underscore their authors' interest in international norm- and standard-setting to ensure that countries engage in lunar exploration under a set of common rules. The entirety of the Artemis Accords, for example, clarifies norms of behaviour in space exploration for its signatories, while the ILRS Partnership Guide includes "*strategy development*", "*joint development of legal documents*" and "*potential definition of future standards*" as cooperation domains for project partners. [61]

Figure 21: ESA & EU Member States and their status in relation to the Artemis Accords

International collaboration is the third most important consideration for actors, with four documents relevant for the topic. They include the two documents explicitly dedicated to enabling interoperability between international partners' technology and the various guidelines for international partnerships, like the Artemis Accords and the ILRS Guide. This focus on international collaboration in lunar exploration **once again underscores just how important such cooperation is for worldwide actors**.

The Artemis Accords in particular are emerging as a key baseline norm-setting document, with 55 signatories as of May 2025 — over a quarter of all UN Members — including 24 of the 30 European countries selected for this Report (see Figure 21).

Overall, the multilateral policy and strategy documents underscore a high level of interest in safety and sustainability, international cooperation and norm-setting among various actors. **Such non-binding documents are likely to continue playing a critical role in establishing broad norms and safety guidelines for cislunar space.**

Civil Society Initiatives on Cislunar Safety

Beyond soft law instruments and initiatives, some **civil societies have been actively providing a platform for discussing cislunar and lunar safety issues and presenting their findings at international forums to support the lunar discussion.** Open Lunar Foundation, Moon Village Association, and For All Moonkind have permanent observer status to the UN COPUOS, enabling them to present their work during the committees' sessions, and encourage countries to participate in different initiatives aimed at strengthening the lunar policy and regulatory frameworks. Open Lunar focuses on topics related to lunar exploration, resources, and governance, whereas For All Moonkind advocates for protecting lunar heritage, especially concerning past lunar landing sites and preserving the human heritage in space. Through its *Best Practices for Sustainable Lunar Activities*, the Moon Village Association defines a common framework for future lunar missions, and its working group, Global Expert Group on Sustainable Lunar Activities (GEGSLA), prepares recommendations on conducting peaceful, safe, and sustainable activities on the Moon and in its orbits. [62]

[61] U.S. Government, *The Artemis Accords*, 2020, (Link); China National Space Administration and Roscosmos, *International Lunar Research Station (ILRS) Guide for Partnership CNSA*. , June 16, 2021, (Link)
[62] Moon Village Association, Best Practices for Sustainable Lunar Activities. MVA, 2020 (Link)

Groups like the Lunar Policy Platform (LPP) and Moon Dialogs also contribute significantly to the general discourse on the cislunar and lunar safety issues. For instance, the LPP's *The Lunar Policy Priorities* report, a document outlining key priority areas for ensuring the safe and sustainable development of the Moon, was presented and discussed during the 2024 COPUOS.[63] Moon Dialogs' *Lunar Policy Handbook* that highlights policy challenges in registration, liability, and transparency, was launched during the COPUOS LSC session in 2023.[64] Moreover, the IISL Working Group on the Future of the Moon Agreement is working on a report analysing current regulatory frameworks governing Moon and lunar activities and also aims to present it during one of the COPUOS sessions.[65]

4.2.3 Analysis of statements at United Nations LSC, STSC and COPUOS

This sub-chapter focuses on the analysis of over 1050 statements submitted by 31 states during the UN Committee on the Peaceful Uses of Outer Space (COPUOS), its Legal Subcommittee (LSC) and its Scientific & Technical Subcommittee (STSC) sessions between 2022-2025 (2025 includes STSC only). Croatia, Estonia, Ireland, Lithuania and Malta are excluded as they are not COPUOS Members. Latvia became a member in December 2024, so only its contributions to the 2025 STSC were considered. The full methodology is available in Annex B.

Out of **the statements submitted by the selected states during the UN COPUOS, LSC and STSC sessions,** 250 mentioned topics relevant to lunar exploration and cislunar safety**.** Within the analysed statements, there are some noticeable key themes: a general increase in lunar discussions, a focus on general long-term lunar sustainability, concerns about safe lunar exploration and research, enhanced efforts towards stronger international collaboration, and advocacy for changes in frameworks and mechanisms governing lunar activities. They showcase **a growing involvement of countries in discussions surrounding cislunar safety issues over the years, reflecting an increasing interest within the European and international community.** This interest is further reflected in the increased activities on lunar topics at the UN**. In 2024, COPUOS created the Action Team on Lunar Activities Consultation (ATLAC)** to further support lunar governance efforts. ATLAC aims to develop recommendations on how to improve international cooperation on lunar activities. Beyond COPUOS and ATLAC, over the last years, the

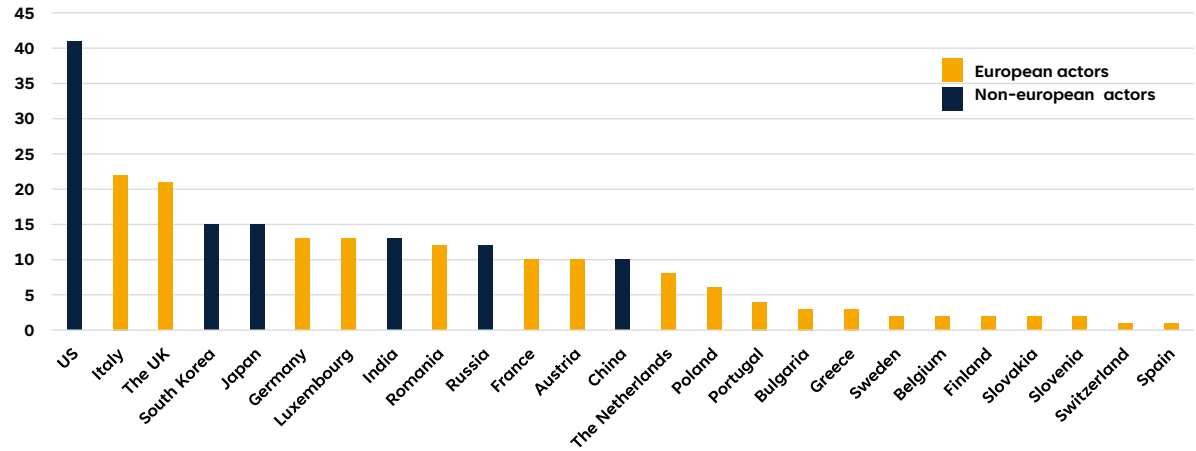

Figure 22: European and non-European countries mentioning cislunar issues (incl. 2025 STSC)

[63] Antonino Salmeri, Lunar Policy Priorities - For safe and sustainable lunar development. Lunar Policy Platform, 2023 (Link)
[64] Moon Dialogs. Lunar Policy Handbook. Moon Dialogs, 2023 (Link)
[65] IISL. "IISL Working Group on the Future of the Moon Agreement." IISL, 2024 (Link)

United Nations Office for Outer Space Affairs (UNOOSA) has also hosted several events linked to ongoing lunar discussions, such as the Sustainable Lunar Activities Conference in 2024 and a workshop on Cislunar PNT in 2025.

Looking at both European and foreign countries that have mentioned lunar issues in their statements, **the U.S. has mentioned them the most, with 41 statements**. The second highest number belongs **to Italy with 22 statements**, and the third goes **to the UK with 21 statements**. **Spain and Switzerland have mentioned them the least, with one statement each** (see Figure 22). Out of the 30 selected European countries, **19 have mentioned lunar issues**. Both the number of European countries producing the relevant statements and the number of statements those countries have produced on the topic **showcase the region's clear interest in lunar matters.**

Analysis of Safety-Relevant Issues

Within statements, seven European and five non-European countries have spoken about issues relevant to the three technical topics: **SSA and STM (including PNT and communications), space debris and end-of-life, and SW.** Overall, **those topics were mentioned 41 times between 2022 and 2025**. Out of those mentions, SSA- and STM-relevant topics were referenced most frequently, with space debris in second place and SW in third (see Figure 23).

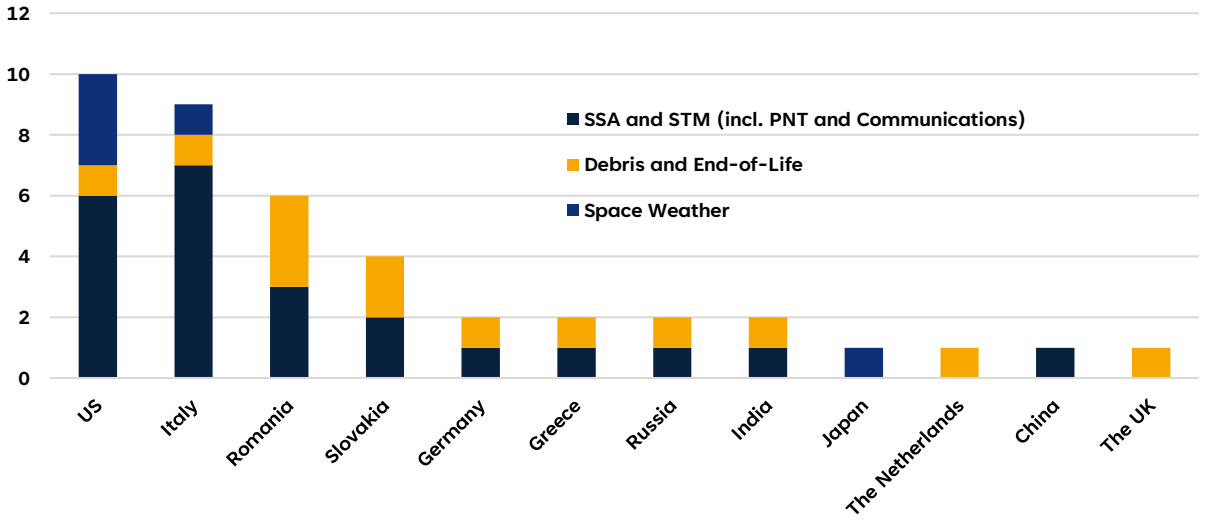

Figure 23: Mentions of safety-relevant issues in UN Statements (incl. 2025 STSC)

On SSA and STM, countries mostly expressed the need to enhance the relevant infrastructure and technologies. One of the themes recurring most often was **the need to establish better communication systems between the Moon and the Earth and enhance PNT in the cislunar environment.** Various countries have highlighted the milestones they achieved in this regard: for example, the US and Italy referenced their joint Lunar GNSS Receiver Experiment (LuGRE), which extends satellite navigation technologies to the Moon, while Slovakia spoke about its SSA telescope that is regularly used for observing space debris from GEO orbits to the cislunar region.[66] China and Russia also expressed their intention to play a leading role in lunar PNT development, with Russia referencing ongoing projects aimed at establishing a national lunar navigation capability.[67]

[66] US, "Statement at STSC 2025", *UNOOSA*, 5.02.2025 (Link); Italy, "Statement at STSC 2025", *UNOOSA*, 6.02.2025 (Link); Italy, "Statement at COPUOS 2023", *UNOOSA*, 31.05.2023 (Link); Slovakia, "Statement at STSC 2023", *UNOOSA*, 8.02.2023 (Link)

[67] China, "Statement at STSC 2025", *UNOOSA*, 5.02.2025 (Link); Russia, "Statement at COPUOS 2022", *UNOOSA*, 8.06.2022 (Link)

As was the case with programmatic developments, **most statements did not touch on SSA proper** — that is, on infrastructure and mission requirements for object tracking in the cislunar environment.

On space debris & end-of-life, most countries were highlighting the need to mitigate the creation of debris in lunar orbits and fund more studies on debris modelling. The U.S. underlined its willingness to continue its self-perceived leadership role in addressing the orbital debris problem from the near-Earth to the cislunar space environment, while the UK announced that it is working on a regulation to address lunar sustainability concerns and minimise cislunar debris. [68]

On SW, several overarching themes emerged: the need for robust SW observation and research to support sustainable human presence in the cislunar environment and reliable forecasting, as well as the call for increased international collaboration on these matters. For instance, the U.S. highlighted the importance of its cooperation with ESA and Japan Aerospace Exploration Agency (JAXA) on the development of SW instruments to be launched on the Lunar Gateway. [69] Italy further underscored the relevance of SW research for various Artemis-related infrastructures, such as the Multi-Purpose Habitat that Italy is building within Artemis. [70]

Overall, the number of statements that include considerations relevant to SSA and STM, space debris and SW remained uneven across the years. **Across all three meetings between 2022 and 2024, the number of mentions almost doubled between 2022 and 2023 to 15, but dipped down between 2023 and 2024** (see Figure 24). Yet, considering that discussions of the topic at STSC more than doubled between 2024 and 2025, **the upward trend seems likely to return** (see Figure 25).

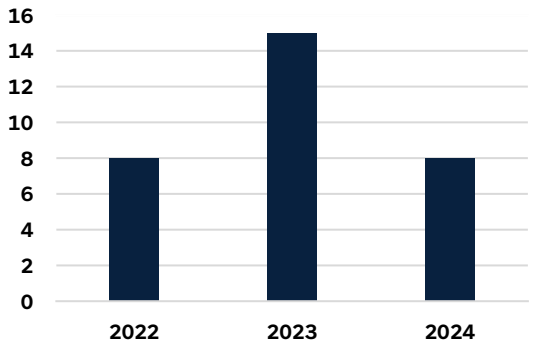

Figure 24: Technical-criteria-relevant mentions across UNCOPUOS, LSC and STSC in 2022-2024

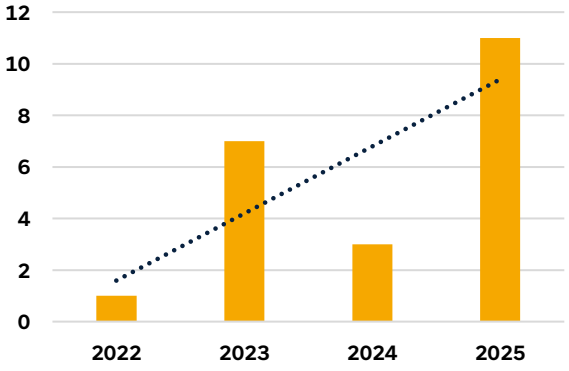

Figure 25: Technical-criteria-relevant mentions at STSC in 2022-2025 and the growth trend

Analysis of Policy-Relevant Issues

The topics related to the Policy evaluation criteria have been mentioned 441 times within the submitted statements. Nineteen European and all non-European countries have spoken about some of the issues relevant to the selected policy topics (see Figure 26).

Out of those mentions, norm-setting, international collaboration, general sustainability & safety orientation, and general lunar ambition were referenced most frequently. The overall analysis of the statements shows that within the COPUOS context, countries tend to focus more on

[68] US, "Statement at STSC 2025", *UNOOSA*, 4.02.2025 (Link); UK, "Statement at LSC 2024", *UNOOSA*, 19.04.2024 (Link)
[69] US, "Statement at STSC 2022", *UNOOSA*, 8.02.2022 (Link)
[70] Italy, "Statement at STSC 2025", *UNOOSA*, 6.02.2025 (Link)

addressing long-term space sustainability issues, discussing regulatory frameworks governing lunar activities, and enhancing international collaboration in cislunar matters.

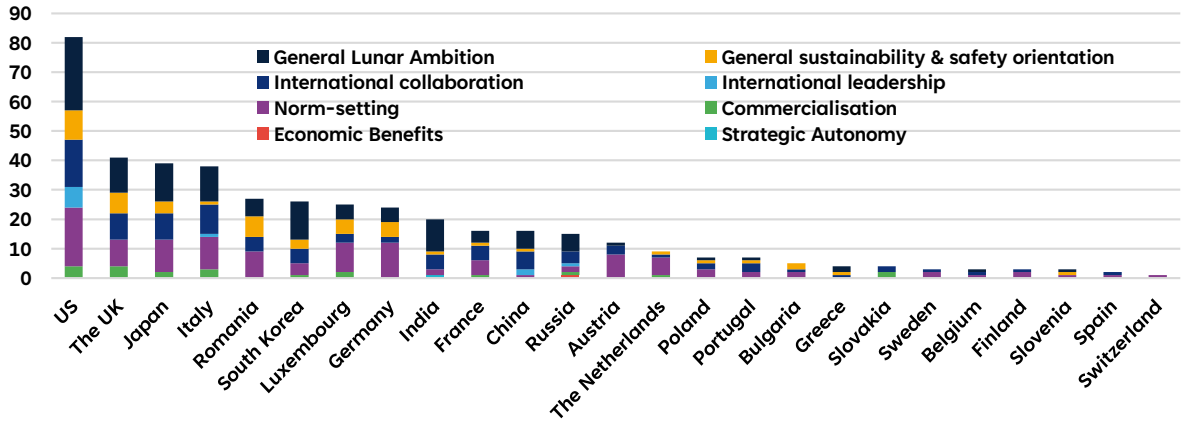

Figure 26: Mentions of lunar policy-relevant issues in UN Statements (incl. 2025 STSC)

On norm-setting, most countries addressed **the importance of establishing transparent principles governing lunar activities**. Romania underlined its commitment to the implementation of the UN Guidelines for the Long-Term Sustainability of Outer Space Activities, stating that the overall objectives of the Guidelines should also include lunar priorities.[71] **Some countries shared concerns about the lack of a relevant legal framework for sustainable lunar-related activities and exploration.** France also stated that in terms of potential changes to the space law framework, **the interests of all involved stakeholders should be properly balanced.**[72]

On general sustainability and safety, the key theme was ensuring the long-term sustainability of cislunar and lunar exploration. South Korea underlined the urgency of safeguarding the safety and sustainability of such activities, a point that was also reaffirmed by the UK.[73] Romania stated that these issues are a permanent concern that requires reaching a consensus at the UN COPUOS level and creating a standardised framework for all actors.[74] Japan highlighted that securing the sustainability of future space exploration should not hinder innovation and should take into account the voice of various actors, including industry.[75]

Overall, the statements showcase **the countries' growing interest in addressing and discussing lunar exploration, including cislunar safety issues, in line with their evolving and growing national ambitions.**

[71] Romania, "Statement at STSC 2023", *UNOOSA*, 9.02.2023 (Link)
[72] Germany, "Statement at LSC 2023", *UNOOSA*, 21.03.2023 (Link); Germany, "Statement at LSC 2022", *UNOOSA*, 28.03.2022 (Link); France, "Statement at LSC 2022", *UNOOSA*, 28.03.2022 (Link)
[73] South Korea, "Statement at STSC 2025", *UNOOSA*, 7.02.2025 (Link); UK, "Statement at LSC 2024", *UNOOSA*, 18.04.2024 (Link)
[74] Romania, "Statement at COPUOS 2022", *UNOOSA*, 8.06.2022 (Link), Romania, "Statement at STSC 2023", UNOOSA, 9.02.2023 (Link)
[75] Japan, "Statement at LSC 2022", *UNOOSA*, 29.03.2022 (Link)

5 AN ANALYSIS OF THE INTERSECTIONS BETWEEN TECHNICAL ISSUES, PROGRAMMATIC DEVELOPMENTS, AND POLICY POSITIONS

To better present the full picture of developments in Europe and abroad, the following chapter takes a **comprehensive look at the data presented throughout the Report on programmatic pursuits, UN statements and policy documents to further clarify the actors' key objectives, as well as opportunities for action**. To further assess the stakeholders' positions on and priorities for cislunar exploration, the team also ran a survey, a consultation campaign, and a closed-door workshop as a side event to LSC 2025. **The cross-sectional analysis and the key results of the survey are presented below.**

5.1 Cross-sectional Overview of Programmatic Developments and Policy Positions

While topics related to safety and sustainability feature more prominently in multilateral space policy documents—largely due to their focus on standardising practices, including those related to safety—they receive significantly less emphasis in national strategies, both across Europe and globally, regardless of the level of programmatic development. Instead, national strategies tend to place greater focus on general lunar ambition.

Beyond just multilateral documents, **certain similarities between European and non-European actors are further highlighted** when looking at which topics were mentioned most often across both national policy documents and statements at the UN (see Figure 27).

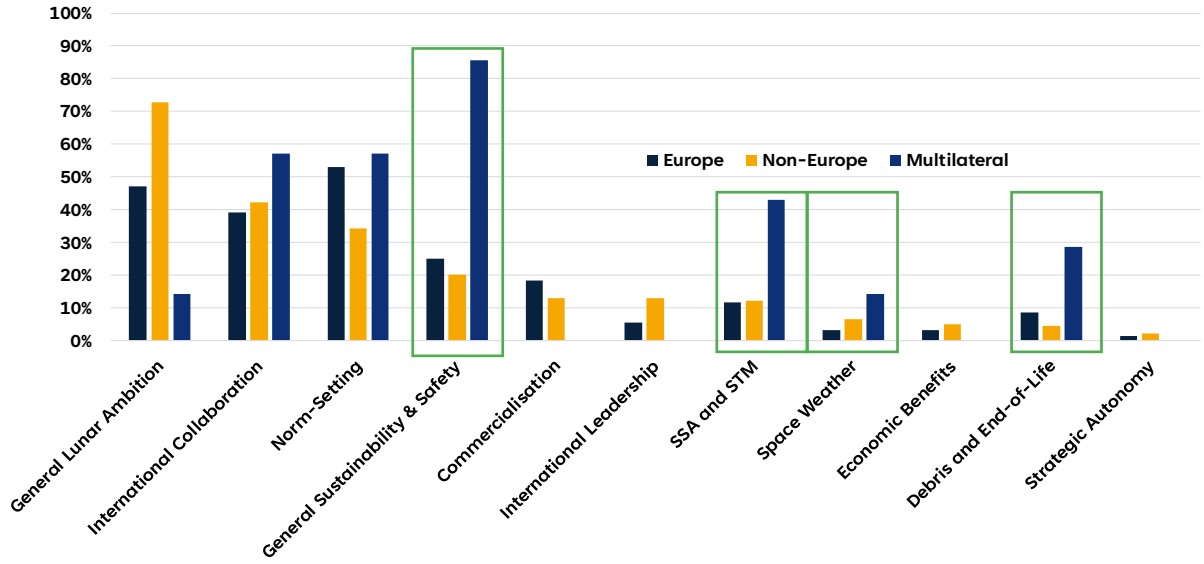

Figure 27: Percentage of documents and statements from analysed actors where topics related to identified evaluation criteria are mentioned. Safety issues boxed in green.

Topics related to SSA and STM (including PNT and communications) were mentioned by actors almost evenly across their national statements and documents, highlighting potential areas of commonality in priorities. These commonalities are supported by discussions in multilateral documents that also largely prioritised international collaboration and general sustainability and safety concerns. **Several points of divergence, however, remain.** Non-European actors are slightly more interested in SW than those from Europe. European countries also seem to prioritise space debris and end-of-life concerns more so than non-European ones and are marginally more interested in commercialisation.

When further comparing cislunar safety priorities elucidated by the countries in their policy documents and their actual programmatic action, some trends emerge. **Only in two European**

countries do the stated safety interests and programmatic action on cislunar safety perfectly align — Italy and the UK. Internationally, only two countries' programmatic and stated safety interests fully align as well — China's and the U.S.'s. Notably, while the U.S. has stated its interest and has pursued action on all three safety challenges, **China has not publicly expressed an interest in dealing with cislunar debris and end-of-life issues either in its policies or programmatically**.

At least ten European countries are contributing to safety-relevant projects without having directly stated their cislunar safety ambition either in their policies or statements at the UN (see Figure 28)**.** Just two of them have expressed at least a general interest in cislunar safety and sustainability, so a general sustainability & safety orientation is unlikely to be the main reason for their participation in these projects. Perhaps the most likely explanation is that even through contributions to safety-relevant missions, those countries are pursuing broader lunar policy means and objectives, such as commercialisation and international collaboration. Internationally, Japan and South Korea are also working on cislunar safety-relevant pursuits across more categories than included in their stated ambitions.

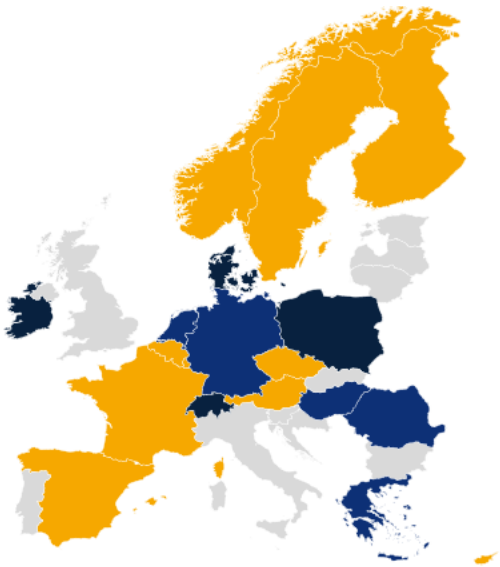

Figure 28: European contributions to lunar projects and assessment of their safety-relevance

While some countries contribute to cislunar safety without having stated their interest in doing so, **expressed safety interests of at least five others have not yet been translated into programmatic action. Four others are contributing only to lunar projects that do not, at this point, explicitly include a safety component** (see Figure 28)**.** This further mismatch of ambition and action suggests that while the interest in cislunar safety pursuits in Europe might be relatively high, it is somewhat haphazardly directed and not yet necessarily streamlined into clear joint projects.

5.2 A Stakeholder Perspective (Survey Outcomes)

The survey was distributed to over 130 stakeholders in Europe and abroad, with the group selected largely due to their prior and ongoing work on cislunar issues. The key results of the survey are summarised in four sections, comprising 'opportunities, challenges, and synergies', 'commercialisation and economic benefits', and 'international cooperation'.

Opportunities, Challenges, and Synergies

The first section of the survey asked respondents to provide their thoughts on the opportunities and challenges in cislunar safety for their respective nations and regions, as well as on synergies between cislunar safety and broader space policy priorities. **Both European and international respondents considered SSA, space debris monitoring and STM as key opportunities for their regions in cislunar safety, followed by an enhancement of SW capabilities and space debris mitigation.** Unlike non-European countries, however, European stakeholders did not see much value in Active Debris Removal (ADR) and space debris remediation capabilities in cislunar space (see Figure 29).

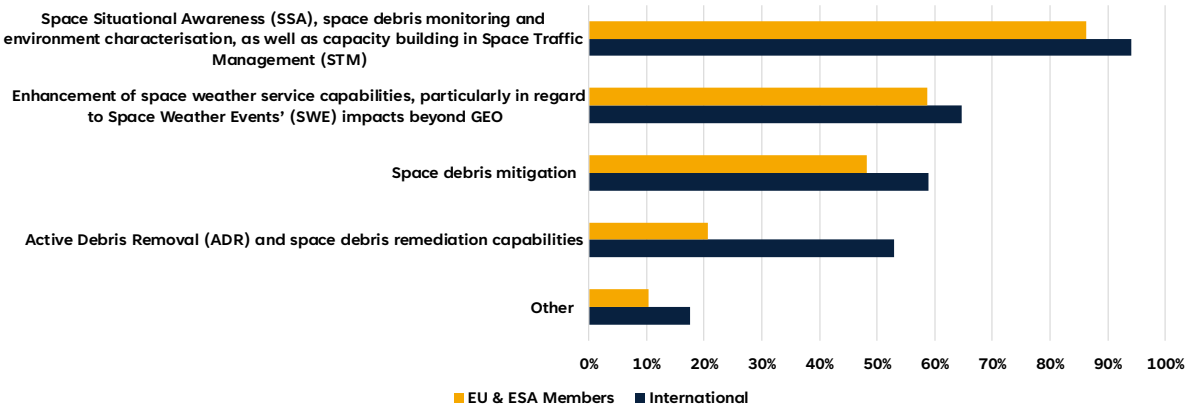

Figure 29: Survey results, "What are the most significant opportunities for your country/region in cislunar safety?"

When asked to identify key challenges for current space policies regarding cislunar safety, the majority of European stakeholders agreed that insufficient funding for relevant initiatives, lack of political will and lack of clarity on responsibility for cislunar safety were the critical issues. International stakeholders agreed that a lack of clear responsibility is a challenge but highlighted fragmented governance as a much more prominent issue (see Figure 30).

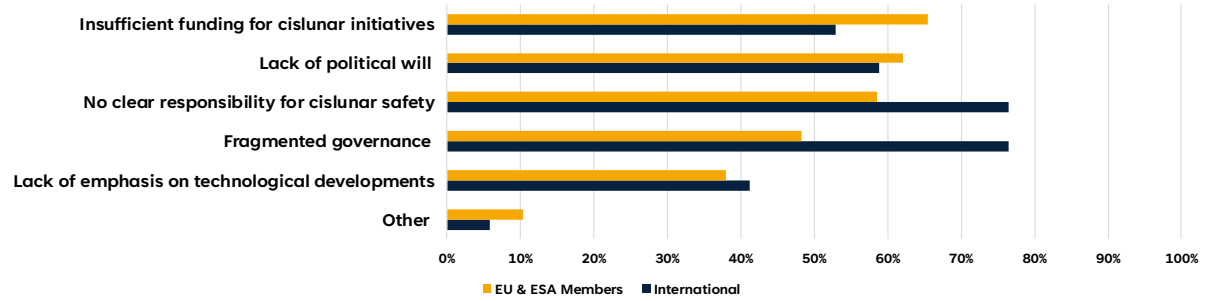

Figure 30: Survey results, "What challenges do you see for current national/regional space policies regarding cislunar safety?"

In a follow-up open-ended question asking which cislunar safety issues should be prioritised at the national/regional policy level, both European and international respondents most often wrote in **issues related to SSA & STM, followed by space debris mitigation**.

Both international and European respondents also highlighted "ensuring sufficient SSA capabilities to protect national/regional assets and citizens" as a key synergy between cislunar safety action and advancement of their broader national space policy priorities. For European actors, other key synergies included enabling further SWE forecasting and protection of investment into future cislunar activities. Internationally, the biggest intersections included support for sustainable approaches to space exploration, demonstration of international leadership, and norm-setting (see Figure 31).

Still, **when asked in an open-ended format** in a follow-up question to expand on which synergies between cislunar safety action and advancement of their broader national space policy priorities respondents found most important and relevant, **SSA & STM emerged as just the third top choice for both European and international stakeholders**. Instead, European respondents most often highlighted international leadership as the most important synergy, while international actors named topics related to commercialisation. The mismatch highlights that even when there is broad agreement on the general list of policy priorities that might be advanced by cislunar safety, the **prioritisation of those synergies can differ quite substantially, potentially precluding agreement on key issues.**

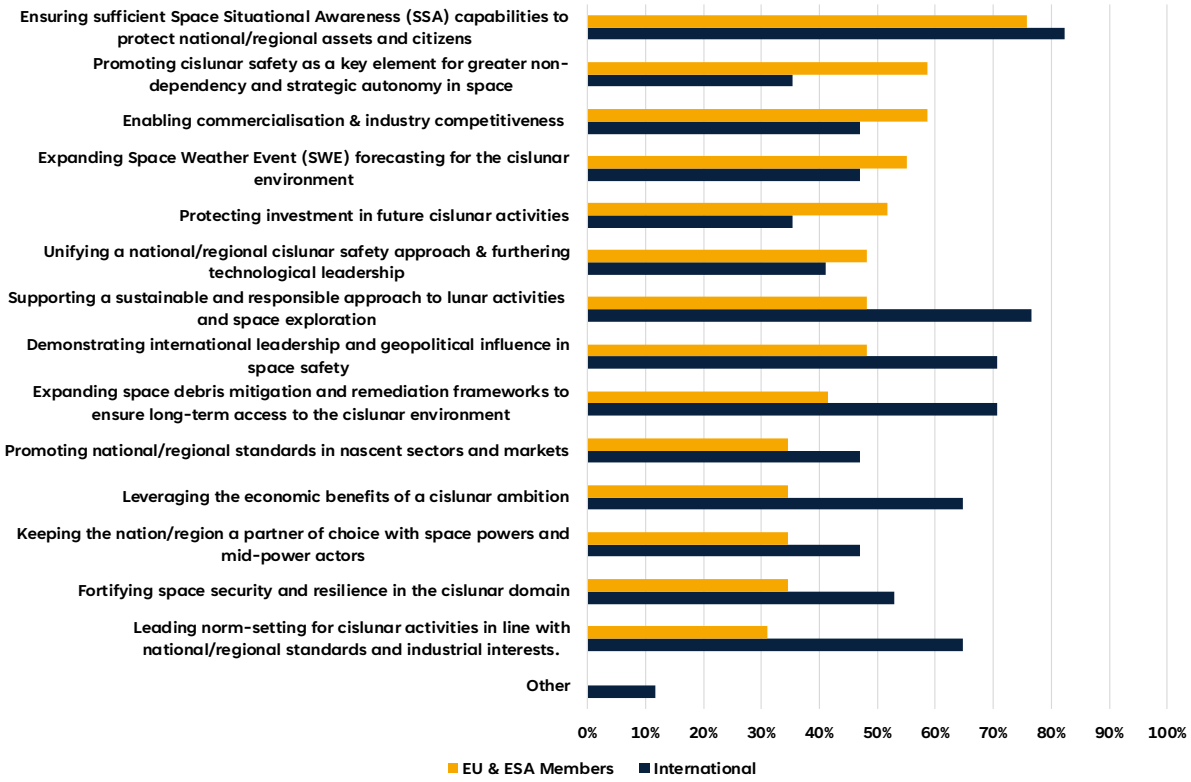

Figure 31: Survey results, "Which broad potential national/regional space policy priorities are likely to be advanced by cislunar safety action?"

Commercialisation and Economic Benefits

The section dealt with commercialisation, industry development and economic benefits that cislunar safety investments specifically may bring. In an open-ended format, **European respondents suggested that the provision of services, such as PNT & Communications and Space Weather, is a key economic opportunity for the region in cislunar space**. Internationally, communication infrastructure and services took second place, with the top economic opportunity spot being given to access to lunar resources. Respondents also expanded on **key barriers to commercialisation in cislunar safety** and suggested ideas on how to involve private companies in safety initiatives. **Both European and international stakeholders agreed that funding opportunities and infrastructure developments** remained critical barriers. International respondents also highlighted the lack of mutual trust among actors as a key issue (see Figure 32).

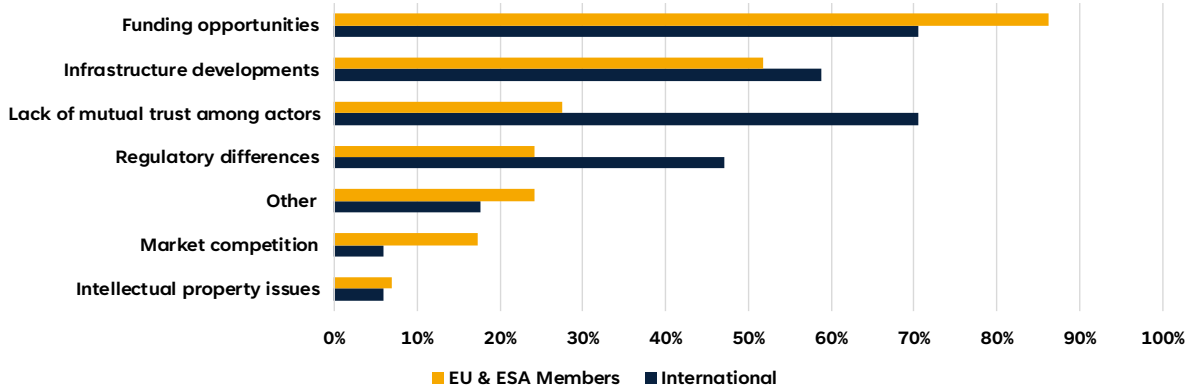

Figure 32: Survey results, "What are the main barriers to commercialisation in cislunar safety?"

In terms of **how to best involve private companies in cislunar safety initiatives, both European and international respondents highlighted public-private partnerships and regulatory incentives as key tools**. European stakeholders also considered direct funding of companies as a potent tool to bring them into the fold (see Figure 33).

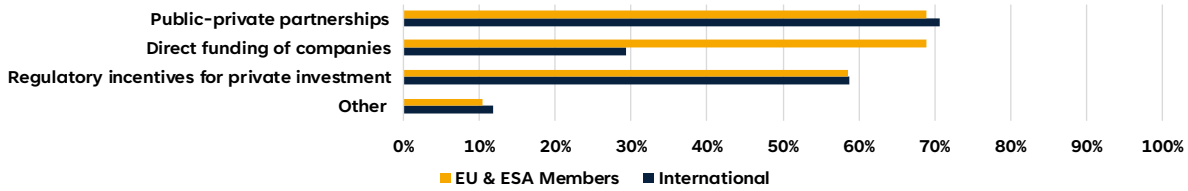

Figure 33: Survey results, "How should your country/region involve private companies in cislunar safety initiatives?"

International Cooperation

The last section assessed the importance of international cooperation in cislunar safety, priority areas for standardisation and the challenges that need to be overcome to ensure that countries can fruitfully cooperate. **Respondents largely agreed that cooperation with like-minded partners is critical for the advancement of cislunar safety**: when asked to rank the importance of such cooperation on the scale from 1 to 5, the average response was 4.3. Yet, **the main rationales for such cooperation differed between European and international stakeholders**. European respondents prioritised joint development of infrastructure as a key reason for international cooperation on cislunar safety, while international actors highlighted international norm-setting as their main rationale. Such an approach suggests that while Europe's push for collaboration is driven largely by budgetary concerns, the international push remains more strategic. Still, both groups agreed that harmonisation of technical standards and enhanced data-sharing were also key priorities (see Figure 34). In terms of standardisation, they suggested that space object registration standards, as well as data format and exchange standards, should be prioritised internationally. Still, to engage internationally, actors will have to overcome some key issues. Both European and international stakeholders agreed that political or diplomatic issues are the primary challenge to international cislunar safety cooperation, while for Europe, financial constraints were also a key issue (see Figure 35).

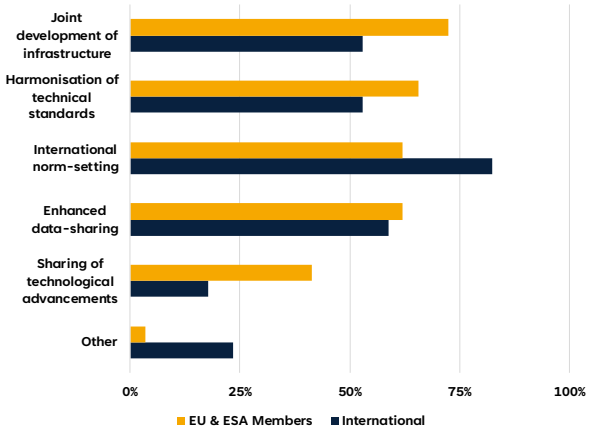

Figure 34:Survey results, "What do you consider to be the main rationale for cislunar safety cooperation between your country/region and other countries?"

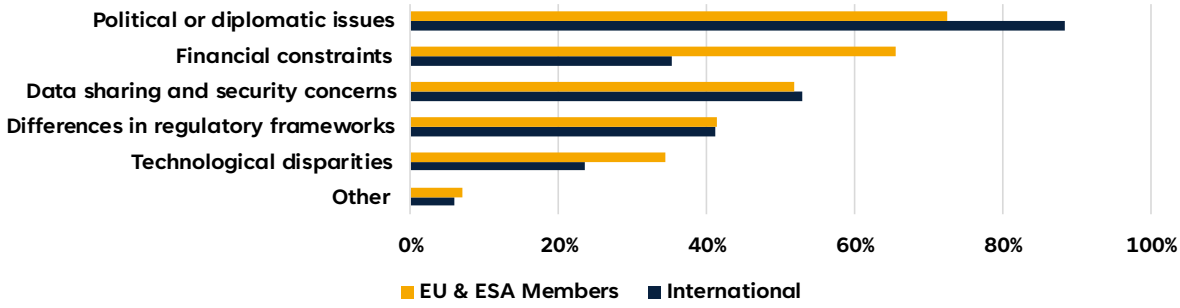

Figure 35: Survey results, "What are the primary challenges for international cislunar safety cooperation?"

6 EUROPEAN ACTION IN CISLUNAR SAFETY

Though many European countries have a lunar ambition and have invested time and resources into its achievement, European action on cislunar safety remains somewhat haphazard, with Member States perhaps not seeing the full enabling and de-risking qualities such activities might offer. While boosting Europe's overall lunar ambition in general is key if Europe wishes to be on equal footing with other global powers, the arguments below show that **such an ambition can benefit from being complemented by cislunar safety infrastructure and policy efforts.**

With this understanding in mind, **the following chapter elucidates five key arguments advocating for European action in cislunar safety from a policy perspective.** The arguments draw on the research and consultations presented thus far, incorporating survey results presented above and the points raised during the consultation and the workshop under the Chatham House Rule.

6.1 Argument 1: Without further safety developments, planned European institutional and commercial lunar missions will have a higher risk of failure

While survey respondents and workshop participants contended that investments in cislunar safety technologies should come after the development of ever-broader European lunar missions, others disagreed. Participation in lunar missions and related cislunar safety developments — whether through the Artemis programme, independent European lunar initiatives, or partnerships with emerging space actors — ensures that European astronauts, technologies, and policies have a place in shaping the future of space exploration. **With organisations like ESA already investing in lunar missions like Argonaut and Member States introducing their own missions, the need for the development of cislunar safety capabilities in Europe is increasing *in parallel.***

While many lunar-faring nations already have experience designing end-to-end lunar missions and can thus perhaps develop them faster if there are no financial or other constraints, the lack of legacy experience working on cislunar safety means longer lead times due to the need for trial and error in the development of those assets. As one workshop participant contended, even investing in safety capabilities immediately would still mean that the capabilities would come later than needed, considering the mismatch between the timelines of already planned European launches to the cislunar environment and the time that would be needed for the development of safety-related capabilities.

As mentioned by multiple stakeholders, a key issue feeding into this reluctance to act is the **mismatch between the stakeholders' perceived level of technological attainment in certain**

cislunar safety capabilities and the reality. When asked to rank cislunar safety capabilities from the "most to least technologically developed", European and international survey respondents on average gave SSA & STM the second spot, with Space Weather services in third (see Figure 36). Yet, for instance, as discussed in Chapters 3 and 4, more payloads so far have been dedicated to SW measurements, rather than pure surveillance and tracking and STM capabilities in the cislunar environment, with existing tools having significant drawbacks. Other capabilities are similarly underdeveloped. **Further development of these capabilities is critical to ensure that planned European missions remain safe in the cislunar environment**.

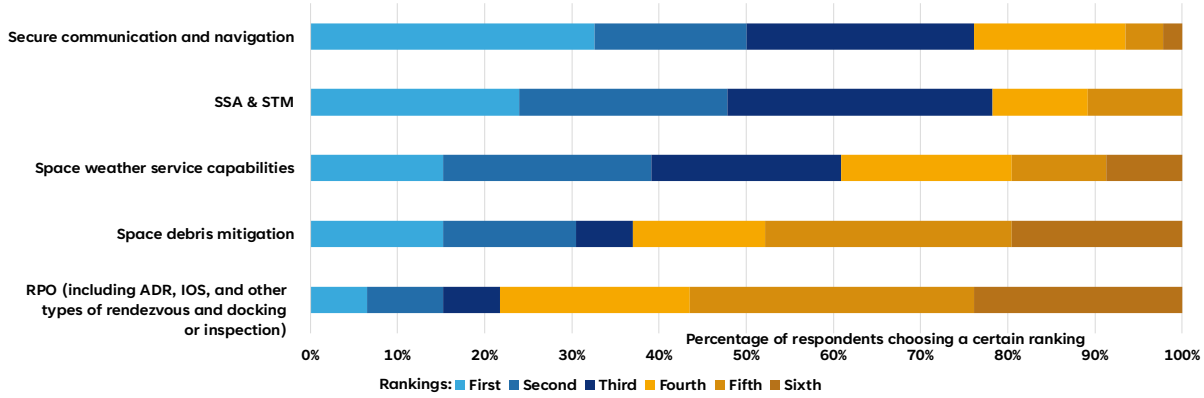

Figure 36: Survey responses, "Please rank the following capabilities in cislunar safety from the most to least technologically developed".

Furthermore, **considering the relatively high current levels of lunar mission failure, investment in cislunar safety capabilities would help de-risk missions** at the early stages as well. Loss of communication with space assets is a key issue in this regard, impacting both institutional and commercial missions: for instance, in February 2025, both NASA's Lunar Trailblazer and AstroForge's Odin flyby mission launched as part of Intuitive Machines Mission 2 failed partially due to communication issues.[76] AstroForge in particular attributed the mission failure in part to ground station congestion and poor ground station coordination.[77] Better-developed cislunar safety capabilities can help reduce the risk of such events in the future.

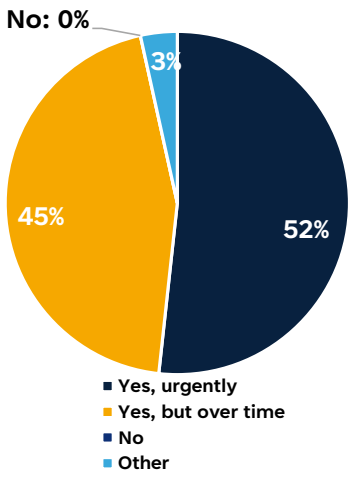

Figure 37: Survey responses, "Should Europe invest in pan-European infrastructures and capabilities to ensure cislunar safety?"

Other survey responses also support more immediate investment in the development of critical cislunar safety technologies. Over 80% of European respondents deemed "SSA, space debris monitoring and environment characterisation, as well as capacity-building in STM" as a key opportunity for Europe in cislunar safety (see Figure 31). Furthermore, though many European capacities in fields like STM are currently dispersed and led by different authorities, 97% of European respondents agreed that Europe should "invest in *pan-European* infrastructures and capabilities to ensure cislunar safety", with 52% of them saying it should do so "urgently" (see Figure 37). Such responses highlight the respondents' commitment to joint European action on the topic.

[76] Jeff Foust, "Lunar Trailblazer, Odin spacecraft suffering problems after IM-2 launch" *SpaceNews.* , 28 Feb. 2025, (Link)
[77] Chapman Snowden, "Odin't: A Complete Debrief of Our Deep Space Mission" *AstroForge.* , 6 Mar. 2025, (Link)

6.2 Argument 2: Promoting cislunar safety investment enables greater strategic autonomy in space and advances European technology

Currently, the **European ecosystem still faces numerous challenges that inhibit a comprehensive and united approach to lunar activities**. As demonstrated in the previous chapters, the national policy and programmatic frameworks suggest that the understanding of key policy priorities in lunar exploration and cislunar safety differs among actors, resulting in a lack of centralised capability. European capabilities are led by different authorities, which makes a cohesive pan-European approach difficult to implement, sometimes precluding Europe from enhancing its strategic autonomy.

Though strategic autonomy has not been reported as a key consideration in lunar exploration for European countries based on their public documents, **stakeholders regularly underscore the key role an interest in strategic autonomy and independence plays in their lunar pursuits broadly and in cislunar safety in particular.** "*Dependence on foreign actors for space security and safety*" was considered by both European and non-European survey respondents to be the biggest risk that would arise from the lack of cislunar safety engagement (see Figure 38). Similarly, over 50% of European respondents suggested that greater non-dependency and strategic autonomy in space would be advanced by cislunar safety action (see Figure 39).

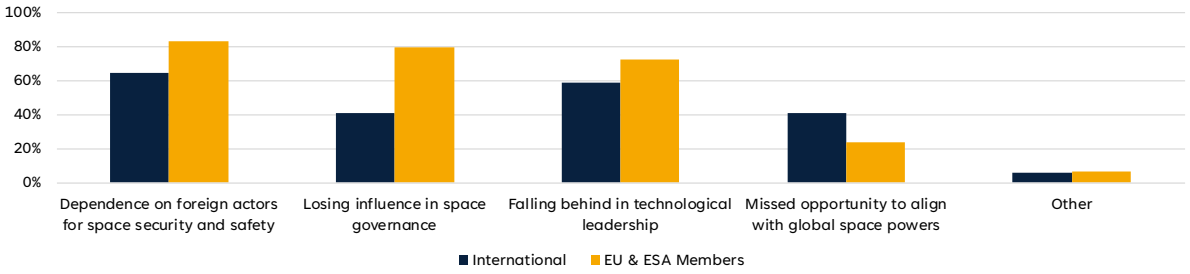

Figure 38: Survey responses, "What political risks might arise from a lack of cislunar safety engagement?"

Such high numbers suggest a key understanding among stakeholders that if Europe *is*, in fact, interested in pursuing lunar missions, it needs to ensure their safety autonomously and independently, without overly relying on traditional partners. Proactively engaging in cislunar safety operations would enable Europe to reduce its dependency on non-European partners for lunar exploration, thereby fostering greater strategic autonomy in space endeavours. This would also ensure Europe continues to be considered as a partner of choice for other nations with lunar ambitions. This has, for instance, been the case with ESA's tracking support to ISRO's Chandrayaan-3 Moon mission.[78]

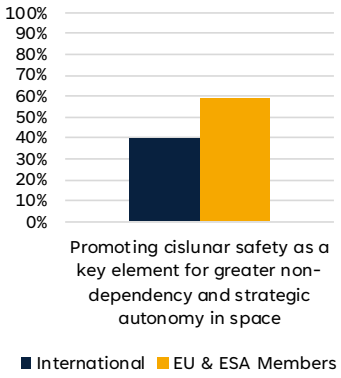

Figure 39: Partial survey responses, "Which broad potential national/regional space policy priorities are likely to be advanced by cislunar safety action?"

Moreover, as cislunar space becomes contested, ensuring the security of European assets in the cislunar environment is essential for both strategic and economic reasons. Developing protective measures — such as SSA capabilities, collision avoidance protocols, interference mitigation strategies, and secure data transmission — will help safeguard European commercial and governmental activities in cislunar space from malicious disruptions. A dual framework that effectively addresses emerging safety risks, sustainability

[78] European Space Agency, "ESA ground stations support Chandrayaan-3 Moon mission" *ESA.* , 13 Jul. 2023, (Link)

challenges, and security and defence threats is crucial for aligning approaches and uniting European actors in a coherent and resilient strategy.

A similar understanding has been emerging in countries outside of Europe, particularly as uncertainties about future U.S. engagement loom. Much of the operational data from the Moon we have right now comes from the U.S., a country that has been increasingly viewing the cislunar environment as a military domain. Such changes in U.S. approaches to the Moon are likely to lead to increased difficulties with open safety information-sharing, requiring other lunar-faring nations to develop their own safety capabilities. European cislunar SSA capabilities are increasingly critical for space object awareness considerations, precisely because relying on third countries — especially geopolitical competitors or even allies with different priorities — presents significant risks and limitations.

6.3 Argument 3: Demand for cislunar safety services can enable further commercial investments and strengthen commercialisation

European industry must remain competitive and innovative, also in view of the projected lunar economy. A cislunar safety ambition that includes investment in infrastructure, technology, and services would enable European firms to develop new infrastructures and services that would set the standard internationally. In this context, commercialisation and industrial action emerge as key priorities for actors in lunar exploration. Enabling and growing European industrial involvement in lunar activities, and ultimately spurring private investment into lunar exploration, is viewed as a crucial way to advance technologies, attain national prestige, and attract more companies into the space sector. Yet, lunar exploration is costly, so **companies and investors are more likely to invest in such ambitions if the missions are operationally de-risked.**

To de-risk the private investments, industry needs both regulatory and infrastructural certainty. On the infrastructure side, governmental investments into cislunar safety capabilities would provide such certainty by highlighting not only that Europe cares about protecting existing national and industry investments but also that it is committed to lunar exploration for the foreseeable future. Survey respondents agree: over 50% of respondents in both Europe and internationally have suggested that “enabling commercialisation and industry competitiveness” is a space policy priority that would be advanced by cislunar safety action (see Figure 40).

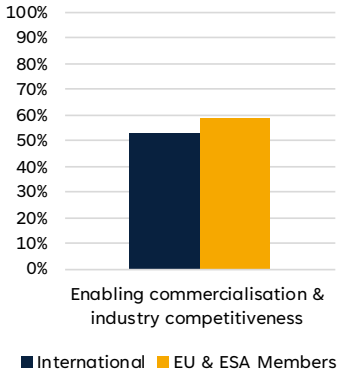

Figure 40: Partial survey responses, “Which broad potential national/regional space policy priorities are likely to be advanced by cislunar safety action?”

Alongside cislunar safety investments, **enhancing commercialisation in the cislunar environment will require dedicated regulatory action**. As the cislunar environment requires different approaches and behaviours to ensure safety compared with those employed in Earth orbits, regulatory clarity on key issues like information-sharing and insurance will ease potential uncertainties commercial actors might have about participation in lunar missions. In this context, enhancing public-private collaborations in Europe can further increase the private sector’s interest in lunar projects. However, it is important to recognise that the lunar and cislunar domain is likely to represent a limited market for the foreseeable future, characterised by a limited number of players operating within a challenging and uneven playing field.

6.4 Argument 4: Cislunar safety investments would help Europe take the lead on sustainable and responsible approaches to lunar activities and scientific exploration

A strong ambition in cislunar safety reinforces Europe's role as a global leader in the responsible use of space. Through various strategies and policy documents, Europe has demonstrated its commitment to leading by example — primarily in the areas of space safety and sustainability. **Advancing leadership in cislunar safety would align with Europe's broader geopolitical objective of ensuring that space remains accessible and secure for all groups and nations.** By investing in cislunar safety technologies, Europe can build critical expertise that supports its own missions while also contributing to those of international partners — thereby strengthening both its diplomatic standing and technological influence. In this regard, **efforts to preserve the lunar environment for both "newcomers"** — countries that are not currently going to the Moon but might in the future — **and scientific exploration will be key**.

For workshop participants, **the need to protect the lunar environment for developing countries was one of the key concerns**. Considering and assessing the priorities of developing countries and involving them in conversations on how current actions on and around the Moon might affect their interests is critical in light of ongoing multilateral discussions on how established spacefaring nations can best support "newcomers" in space. Europe can further promote its commitments to multilateralism and sustainability by either already engaging such newcomers in joint cislunar projects, leveraging their expertise on capabilities that might be necessary for lunar exploration and safety, or simply ensuring that the space environment does not continue degrading before the "newcomers" have their shot.

Similarly, scientific pursuits on and around the Moon have been highlighted as a key priority for nations both in Europe and worldwide. Yet, lunar exploration without dedicated safety capabilities can irreparably harm the areas of the Moon that are critical for future scientific pursuits. When relying only on existing capabilities for cislunar safety, it will be just a matter of time until events like spacecraft collisions and the ensuing falling debris render critical scientific sites useless. **Considering the importance of scientific pursuits on the Moon for both European and non-European countries**, as highlighted in their policies, an engagement on cislunar safety issues from a point of view of **protecting the Moon for science can be a fruitful way to get political groups to find common ground**.

Going beyond diplomatic efforts, **a key part of lunar safety action also involves working with operational communities — scientists, engineers, and industry — who know exactly what the risks to their work are and which safety capabilities are required to avoid those risks.** Europe should bring regulatory and operational communities together to ensure that its cislunar safety capabilities are sufficient for the achievement of its key priorities on the Moon, further highlighting its role as a leader in multilateral approaches to space safety and sustainability. **Enhancing expert-to-expert communications on cislunar safety**, especially in intra-agency formats, **can also help enhance our understanding of critical cislunar safety issues and improve international action on the topic**. While purely diplomatic paths toward an agreement might be lengthy, experience shows that when inter-agency and scientific groups find a consensus on certain space safety topics, their work enables the political and diplomatic processes on the subject to proceed much more smoothly.

6.5 Argument 5: Cislunar safety action can help Europe to position itself in international norm- and standard-setting

Independent lunar norm- and standard-setting is considered a key priority outside of Europe: over 60% of non-European survey respondents suggested that "leading norm-setting for cislunar activities in line with national/regional standards and industrial interests" is a key national priority that would be advanced by cislunar safety action (see Figure 41).

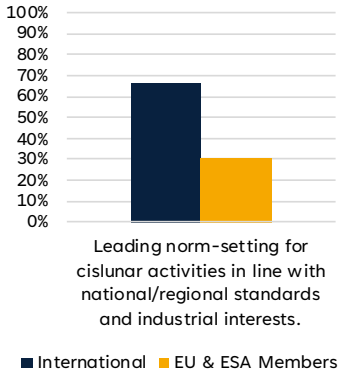

Figure 41: Partial survey responses, "Which broad potential national/regional space policy priorities are likely to be advanced by cislunar safety action?"

In Europe, the commitment to the topic is not quite as clear. Though European countries mention topics relevant to norm-setting quite often in UN Statements, they are most often mentioned in connection with the nation's participation in U.S.-led Artemis Accords, rather than independent pursuits**.** Furthermore, just over 30% of European respondents suggested that norm-setting for cislunar activities would be advanced by cislunar safety action in the multiple-choice question (Figure 41). Yet, norm-setting emerged as one of the top-three priorities when, in the follow-up open-ended question, the respondents were asked to write in "which of the priorities [they] selected they found the most relevant". **This oscillation on the commitment to norm-setting perhaps reflects Europe's uncertainty about its future lunar exploration pursuits** — and thus the need for national and international norm-making on the topic.

Current efforts in international lunar norm-making, however, will likely not stay confined to the Moon. As a workshop participant contended, the way international space norms and standards get reinterpreted now in relation to the Moon will have far-reaching implications for future exploration of the solar system, the universe and perhaps even circle back and prompt us to reinterpret our engagement with Earth orbits. Thus, **if Europe does not participate in international norm-making on lunar issues, including cislunar safety, now, it runs the risk of having to follow rules written by someone else for other space exploration destinations.** Some European countries are already seeing that and reacting accordingly: for instance, the UK is already engaging in national norm-setting on cislunar issues and is planning to promote its example via diplomatic channels. Still, while national regulations are a good place to start, they will likely not be enough. **International norm- and standard-setting efforts are credible most often only when they are backed by national and regional capability developments.** Thus, investment in lunar missions and initiatives, including those in cislunar safety, is required for Europe to credibly engage in norm-setting on cislunar safety issues and ensure that European approaches are adopted for safety in exploration in the future.

7 CONCLUSION

Without a proactive ambition in lunar exploration supported by cislunar safety activities, Europe risks falling behind global competitors and losing influence over how the lunar domain is and will be governed. By instead positioning itself as a leader in responsible exploration, technological innovation, and competitiveness, Europe can secure its place in the next phase of space exploration development. **At a time when the U.S. is reshaping its lunar ambitions, Europe has a unique opportunity to establish itself as a future-defining and principled actor.**

Concerted action on the three cislunar safety areas identified in this report would be particularly important for such a pursuit. Due to the mismatch in perceptions of and actual technological attainment in these three cislunar safety areas, little attention has been paid to critical issues in cislunar space like SSA&STM, space debris mitigation, and space weather. Yet, **considering the challenges of the cislunar environment, further safety action on those issues and beyond is critical to ensure the preservation of assets, astronauts, and European interests in cislunar space**.

SSA & STM

Since enabling **SSA & STM** in cislunar space was considered a key opportunity in cislunar safety for Europe by consulted experts, **it would be warranted to prioritise investments in this area**. Though some stakeholders may consider existing infrastructure sufficient, research into the SSA & STM challenges in the cislunar environment underscores that **existing assets are insufficient as cislunar space grows increasingly congested**.

ESA can play a key role in the cislunar SSA & STM development in Europe, considering its ongoing preparations for a space-based cislunar surveillance and tracking mission and the fact that, as highlighted in this report, most European countries already engage in lunar exploration primarily through ESA missions — missions that need to be better tracked and de-risked. Out of the three safety areas analysed in the report, **SSA & STM is also perhaps the best area to engage commercial actors in cislunar safety projects**, as highlighted by the existence of cislunar SSA projects like Oracle in the U.S. Further development of SSA & STM for the cislunar environment can also synergise with advancements in these fields needed for Earth orbits, thus enabling safety closer to home as well.

Space Debris

The approach to debris mitigation in Earth orbits has been largely *reactive* — characterised by efforts to remove existing debris alongside future mitigation. **In cislunar space, Europe has an opportunity to be proactive, rather than reactive, and prevent the proliferation of debris from the get-go**, learning from developments in Earth orbits and enhancing the continent's standing in space safety and sustainability. **At the moment, the focus can be on mitigation, including dedicated end-of-life procedures.** While cislunar ADR is not currently viewed as a key interest by European stakeholders, the development of that kind of technology for cislunar space can be considered in the future, also given the necessary development of RPO capabilities and their dual-use nature that might become relevant over the coming decade.

Considering the impact unmitigated debris and unsustainable end-of-life procedures may have on the lunar surface — for instance, if large numbers of decommissioned spacecraft are just crashed into it — **it is important to also engage the scientific community on the subject to ensure that mitigation guidelines address the most pressing issues.** Updates to existing space sustainability guidelines and regulations can also be considered, following documents like ESA's current Space Debris Mitigation Requirements that include cislunar issues or forthcoming UK legislation on the sustainability of cislunar operations.

Space Weather

Space Weather has also been viewed by over 50% of survey respondents as a key cislunar safety differentiator for Europe. **To better understand and mitigate the potential impacts of extreme space weather events on the cislunar environment, further investments — in consultation with the scientific community — are needed**. Such investments can include payloads and experiments dedicated to better forecasting and impact studies. **Investment in better SWE forecasting for the cislunar environment will also directly improve our ability to forecast events that might affect spacecraft stationed in Earth orbits**, highlighting the potential wider impact of such investments.

Europe stands at a **pivotal moment in shaping the future of (cis)lunar policy**. Without a clear and proactive pillar in cislunar safety, the continent risks losing ground to global competitors and diminishing its influence over the governance of the lunar domain.

Overall, regardless of Europe's participation, the **current momentum in lunar activities signals a transformative era**, positioning lunar exploration as an emerging priority for both established and aspiring space nations. Numerous stakeholders are advocating for a stronger European commitment to space exploration, with the Moon taking a central and strategic role. This perspective is echoed in the *Revolution Space* report, presented by the High Level Advisory Group to ESA in 2023.[79] The 2025 ESA Ministerial Council presents Europe with a generational opportunity to enhance its technological, cultural, and economic standing on the global stage by advancing a more ambitious lunar agenda. Within this context, Europe can integrate cislunar safety into its broader exploration strategy, helping to de-risk future institutional and commercial missions. By asserting leadership in responsible exploration, technological innovation, and commercial competitiveness, Europe can secure a strategic position in the next era of space development. This approach will ensure that Europe not only safeguards its interests but also promotes a stable and sustainable space environment for all.

ESPI Vision on Space Exploration

ESPI supports the findings of the High-Level Advisory Group's report, *Revolution Space*, and particularly the emphasis on protecting our orbital environment and advancing space exploration. In alignment with *ESPI Vision 2040*,[80] ESPI's research agenda includes dedicated themes on **"Exploration & Science: Inspiring Europe Through New Frontiers"** and **"Space as an Asset: Securing Europe's Ability to Decide and Act",** with the latter addressing space safety and sustainability issues. The former reflects ESPI's commitment to fostering a future where, by 2040, Europe has significantly advanced its exploration capabilities and established an autonomous presence in LEO, lunar orbit, and on the Moon. ESPI promotes an integrated view, in which space applications, exploration, and science are inseparable pillars of a strong space sector, essential for delivering maximum societal and strategic benefits. Our goal is to ensure that Europe remains at the forefront of space science and exploration, building on its legacy of groundbreaking missions such as *Rosetta* and *Huygens*, and leading new flagship missions of global significance that deepen humanity's understanding of the universe.

ESPI will **continue to support stakeholders through strategic analysis on key issues related to science and exploration**. We aim to foster an active dialogue between policymakers, scientific institutions, and industry to secure the political recognition and policy direction necessary for European leadership in this domain.

[79] High-Level Advisory Group on Human and Robotic Space Exploration for Europe, *Revolution Space*, ESA, March 2023 (Link)
[80] European Space Policy Institute, *ESPI 2040*, ESPI, January 2024 (Link)

ANNEX A – LIST OF ABBREVIATIONS

ADR	Active debris removal
ATLAC	Action Team on Lunar Activities Consultation
ASI	Italian Space Agency
CNES	National Centre for Space Studies
COPUOS	Committee on the Peaceful Uses of Outer Space
COSPAR	Committee on Space Research
CR3BP	Circular Restricted 3-Body Problem
CSA	Canadian Space Agency
DLR	German Space Agency
ESA	European Space Agency
HALO	Habitation and Logistics Outpost
ILRS	International Lunar Research Station
ISECG	International Space Exploration Coordination Group
ISRO	Indian Space Research Organisation
ITU	International Telecommunications Union
JAXA	Japan Aerospace Exploration Agency
JPL	Jet Propulsion Laboratory
L1, L2, L3, L4, L5	Lagrange Points
LLO	Low Lunar Orbit
LSC	Legal Subcommittee
MADCAP	Multimission Automated Deepspace Conjunction Assessment Process
MPH	Multi-Purpose Habitat
NASA	National Aeronautics and Space Administration
PNT	Positioning, Navigation and Timing
RPO	Rendezvous and Proximity Operations
SSA	Space Situational Awareness
STM	Space Traffic Management
STSC	Scientific & Technical Subcommittee
SW	Space Weather
SWE	Space Weather Event
TLE	Two-Line Element Set
UKSA	UK Space Agency
UN	United Nations
UNOOSA	United Nations Office for Outer Space Affairs

ANNEX B – METHODOLOGY

The study provides an overview and analysis of cislunar safety pursuits across all EU and ESA Member States, as well as across six non-European countries that have been most prominent in lunar exploration in recent years, with pursuits of 36 countries analysed in total. The countries included are, namely:

Europe					
Austria	Czech Republic	Germany	Latvia	Poland	Spain
Belgium	Denmark	Greece	Lithuania	Portugal	Sweden
Bulgaria	Estonia	Hungary	Luxembourg	Romania	Switzerland
Croatia	Finland	Ireland	Malta	Slovakia	The Netherlands
Cyprus	France	Italy	Norway	Slovenia	The UK
Non-Europe					
The United States	China	India	Japan	South Korea	Russia

Table 3: Analysed countries

To arrive at the criteria for analysis, the authors conducted **a comprehensive literature review** of technical and environmental challenges in cislunar space, as well as a review of the most prominent space policy concerns in Europe and around the world that may potentially intersect with lunar exploration priorities. **The literature review of technical issues is presented in Chapter 3 of this Report**. Based on the issues emerging through the literature reviews, the authors **have selected eleven areas for analysis that are utilised throughout the report:**

Evaluation Areas	Evaluation Broad Criteria	Criteria description
Focus Area Evaluation	SSA and STM (incl. PNT and Communications)	Programmes, statements and documents focused on: • Tracking infrastructure in cislunar space • Data-sharing rules for cislunar space • Rules of the road in cislunar space • Coordinated time reference in cislunar space • Uniform spatial reference schemes in cislunar space • Reliable communications infrastructure for cislunar space
	Debris and End-of-Life	Programmes, statements and documents focused on: • Avoiding the creation of debris in cislunar space • Mitigating the potential impact of debris in cislunar space • End-of-life procedures in cislunar space
	Space Weather	Programmes, statements and documents focused on: • Enabling better Space Weather Event forecasting for cislunar space • Need for more research into Space Weather impacts in cislunar space

Policy Evaluation	Objectives	General Lunar Ambition	Statements and documents mentioning: • The actor's interest in lunar exploration • The actor's contributions to lunar missions The actor's participation in lunar-specific forums
		Strategic Autonomy	Statements and documents mentioning: • Lunar missions as enabling further autonomy in space • An interest in pursuing independent, national lunar missions
		Economic Benefits	Statements and documents mentioning: • Positive impacts of involvement in lunar missions for the national economy, such as job creation
		International Leadership	Statements and documents mentioning: • A country's interest in establishing itself as a leader in lunar exploration • A country's existing perception of itself as a leader in lunar pursuits
		General Sustainability & Safety Orientation	Statements and documents mentioning: • A country's general commitment to sustainable and safe lunar exploration
	Means	Commercialisation	Statements and documents mentioning: • Participation in lunar missions as an enabler of the national space industry's development and competitiveness • National commercial actors and commercial partnerships either already working on lunar missions or planning to pursue them • Future lunar markets
		International Collaboration	Statements and documents mentioning: • A country's interest in collaborative lunar exploration • A focus on interoperability of various lunar missions • Existing participation in international lunar missions (e.g. through ESA or U.S. Artemis programme)
		Norm-Setting	Statements and documents mentioning: • A country's interest in developing norms and rules for lunar actors, independently or through existing international programmes and forums • A country's general interest in ensuring common norms and standards for lunar actors

Table 4: Evaluation Criteria

Due to the complex nature and diversity of lunar exploration pursuits in Europe and around the world, the exact timeframe and methodology for each section varied. The section-specific methodologies are described below.

Programmatic Development Analysis

The objectives of this section were to map out launched missions by analysed countries and their participation in missions launched by other countries, focusing particularly on the missions' safety-relevant payloads; and planned safety-relevant missions and projects by analysed actors, including those that will support safety from Earth. Beyond the countries described above, this section also includes missions run by ESA, as many European countries engage in lunar activities largely through

their participation in ESA's missions. Missions and projects included those launched and announced between 2018 and the end of February 2025. The starting year was selected as the first year after the U.S. announced its intent to return to the Moon with the Artemis programme, often considered in literature to be the beginning of the new lunar race.

To ensure that the most relevant projects are found, the team utilised desk research tools, going country by country and payload by payload, as well as consulted with ESA's Space Safety Team to minimise omissions. The authors then combined quantitative and qualitative analysis tools to assess the trends and spreads within the data. Criteria-wise, the programmatic analysis assessed only whether the programmes fell under the three Focus Area criteria to elucidate the interest in safety programmes.

European and Non-European National Policy and Strategy Analysis

The objective of this section was to identify the mentions of topics relevant to the evaluation criteria within countries' national space-specific government-issued policy and strategy documents to further clarify the contexts in which they mention their lunar pursuits. Though countries clarify their space ambitions through various means, including parliamentary hearings, cross-sectoral policies and other documents, the authors analysed only the broad national space-specific policies and strategies for consistency across the sample. The timeframe varied to ensure that all the latest published versions of space policy and strategy documents in each country were included. For the U.S., documents from the past two administrations were utilised to align with the timeframe of the country's decision to return to the Moon.

The team identified 107 policy and strategy documents in selected countries and utilised qualitative coding methods to assess the contexts in which lunar topics were mentioned in the documents, then translating them into quantitative data to assess broader trends. This section also included an analysis of cislunar safety priorities elucidated in strategies and guidelines produced by ESA, since many European countries participate in lunar exploration primarily through ESA. Five such documents were analysed.

Multilateral Policy and Strategy Analysis

As national pursuits in space are also guided by established international norms and standards, the objective of this section was to identify which international policy and strategy documents are relevant for the analysed countries in their lunar pursuits. Through broad desk research, the team identified seven documents on lunar policy and space exploration (if lunar exploration topics were included in them) produced by groups, forums and entities with participation of governments or space agencies of the analysed countries. Here, the team reverted to the programmatic timeline — looking for documents produced or updated between 2018 and 2025 as lunar exploration intensified in that timeframe. The team utilised qualitative coding methods to assess the contexts in which lunar topics were mentioned in the documents, then translating them into quantitative data to assess broader trends.

Analysis of Statements at United Nations LSC, STSC and COPUOS

The objective of this section was to identify the mentions of topics relevant to the evaluation criteria within countries' statements at the UN COPUOS, LSC, and STSC to clarify the contexts in which they mention their lunar pursuits. This part of the analysis does not include Croatia, Estonia, Ireland, Lithuania, and Malta, as they are not members of the UN COPUOS. Latvia only became a member in December 2024, so only its contributions to the 2025 STSC could be analysed. The timeframe included 2022-2025, with only STSC statements included in 2025, as only they were available at the time the data collection was undertaken. As the conversation on lunar topics at international forums has intensified only recently, the timeframe was selected to limit the assessment to the most prominent and

current priorities. The research team collected all statements submitted by analysed actors via the UNOOSA website, with 1066 statements in total. As the majority of the statements were unlikely to mention lunar priorities, the team ran a bulk search through all the statements using a list of basic keywords and their cognates related to lunar topics: *Moon, lunar, cislunar, Artemis, Gateway.* Through the automated search, 250 statements that mentioned lunar topics were identified and selected for further analysis. The team utilised qualitative coding methods to assess the contexts in which lunar topics were mentioned in the statements, then translating them into quantitative data to assess broader trends.

Cross-Sectional Overview

The analysis of gaps and key priorities across all programmes and documents proceeded in two steps:

- A table was made indicating whether a country mentioned issues relevant to specific Evaluation Criteria in its policies and UN statements, as well as whether it is contributing to safety programmes or other lunar exploration missions based on the programmatic analysis to clarify particularly the programmatic gaps;
- Absolute numbers of mentions of each topic by EU & ESA states and non-European states were compiled from both their UN Statements and national policy documents and were then compared with the number of analysed documents from each group to clarify the percentage of documents mentioning each topic.

Such an approach allowed the team to assess the overall publicly presented goals and objectives in lunar exploration for analysed countries and establish the key omissions in policy and programmatic action.

Survey, Consultation Campaign and Closed-door Workshop

To further confirm stakeholders' positions on and priorities for lunar exploration, the team also ran a survey, a consultation campaign, and a closed-door workshop as a side event to LSC 2025. The survey was distributed to over 130 stakeholders in Europe and abroad, with the group selected largely due to their prior and ongoing work on cislunar issues and participation in relevant forums. The team received 46 responses to the survey. Another six stakeholders were interviewed, and 24 participated in the closed-door workshop. The survey presented a mix of multiple-choice and open-ended questions to ensure that respondents could also discuss the priorities that may have been not pre-identified by the research team. The 46 survey respondents hailed largely from Europe, North America and Asia-Pacific. The respondents represented various sectors, with around 55% coming from research & academia or space agencies (see Figure 42). Almost all respondents were at least somewhat familiar with cislunar space activities, and over half of them have worked on cislunar topics for over four years (see Figure 43, Figure 44).

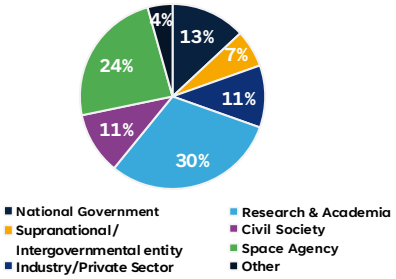

Figure 42: Survey results, "What sector are you working for?"

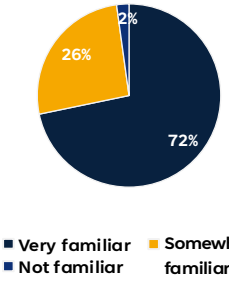

Figure 43: Survey results, "How familiar are you with cislunar space activities?"

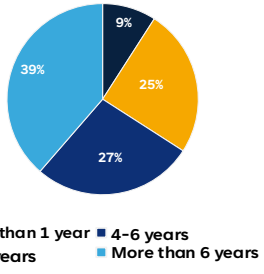

Figure 44: Survey results, "How long have you been involved in cislunar space activities?"

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Perspectives presented in this report are ESPI's viewpoints and do not necessarily reflect the opinions of the individuals who were interviewed as part of this research.

Survey, consultation campaign and closed-door workshop participants

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A non-comprehensive list of the stakeholders who provided their highly appreciated opinions and perspectives is presented below.

List of Interviewees	
Christopher D. Johnson	Director of Legal Affairs and Space Law, Secure World Foundation
Diane Howard	Former Director of Commercial Space Policy, the U.S. National Space Council
Shyama Narendranath	Senior Scientist, ISRO
Jean-Claude Worms	Executive Director, COSPAR

Technical Experts in ESA

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Current and former ESPI staff

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