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LUNAR INDUSTRY VISION COUNCIL

LUNAR INDUSTRY VISION 2024

September 2024
Lunar Industry Vision Council

Humanity has faced the unknown and overcome it countless times on Earth. In the near future, we will do the same—only this time on the Moon and beyond. By the 2040s, there will once again be astronauts working, and even living, on the lunar surface. We will once again face great unknowns, which is why we need a vision to guide the way. Our aim as visionaries is to understand how our nation's technological base can be applied to the peaceful development of the Moon, and then bring together the combined expertise of industry, academia and government to create a new lunar industry.

In 2008, Japan enacted the Basic Space Law with support from across the political spectrum. This law steered the nation from an era of space development to one of realizing the economic potential of space.

In the sixteen years, we have been working on legislation essential for the promotion of a commercial space industry, such as the Space Activities Act and the Satellite Remote-Sensing Act. In June 2021, Japan's enactment of a Space Resources Act, only the fourth of its kind in the world, generated considerable interest in other countries. The Lunar Industry Vision Council will continue to seek support for a commercial space industry at home, while also strengthening Japan's role as a global leader in establishing rules for international cooperation and the promotion of private-sector involvement in space. NASA's Artemis Accords, to which Japan is a signatory, are an important symbol of Japan-U.S. cooperation in the field of lunar exploration. At the same time, the development of a private-sector lunar industry should also be high on the agenda. There is fierce international competition to gain a foothold on the Moon, but we must work together with other countries that share our vision for a lunar industry. We offer this vision to the people of Japan and the world, and we hope that our current and future leaders will share our ideals for the peaceful, commercial development of the Moon for the benefit of humankind.

Chairperson Kawamura Takeo
(Former Chief Cabinet Secretary, Liberal Democratic Party of Japan)

The development of a commercial lunar industry is vital to our future in space, which is why I am truly honored to serve as a Chair of this Council.
The strong leadership shown by each of the participants has enabled us to put together a Lunar Industry Vision that is unique to Japan and unparalleled in the world. This vision is not a reflection of the Japanese Government's industrial policy but represents the long-term aims of the private sector. It is my view that strong government support for private-sector initiatives is one of Japan's unique strengths. Coincidentally, in May of this year, the Cabinet Office released a report outlining its basic approach towards lunar activity, which I believe will further strengthen cooperation between government and industry. With this Vision, we hope to spur the Government to press boldly ahead and ignite a movement with private-sector innovation to the fore. Looking back at the Earth from the Moon will profoundly change the perspectives not just of industry but of humanity as a whole. I hope our vision will become known the world over and inspire passion and momentum behind our quest for a lunar industry.

Chairperson Atsushi Kakunan (The Sasakawa Peace Foundation)

My fascination with the Moon got me into trouble at an early age. As an elementary school student, I spent hours looking at lunar craters through a telescope. Eventually, I made a “Moon” out of a globe by coating it with clay. When I proudly submitted it as my summer homework, I remember being scolded by my mother for ruining the globe she had bought me. Ten years later, I was looking for a job in the space sector. And now, another 30 years later, I am reflecting on the joy of being involved in lunar work as a politician. Developing a viable lunar industry requires a vision with the private sector at its core. I would like to see an industrial ecosystem built on the lunar surface, to operate there in conjunction with government-funded work on lunar infrastructure and scientific research. I believe that this is a vision in which industry, academia and government are all pointing in the same direction, so I have high hopes that all parties can make steady progress and overcome any obstacles that lie in our way.

Acting Chair　Ohno Keitaro (Member of the House of Representatives)

Since the establishment of the Lunar Industry Vision Council in 2021, significant progress has been made in both government and private-sector lunar initiatives. Japan is taking a leading role in the lunar domain—particularly in terms of policy, science, and industry.

Now is the time to further accelerate this momentum and establish Japan's global presence ahead of the curve. We have updated the Lunar Industry Vision and defined seven new industrial sectors as part of this effort.

We have also formulated our seven declarations and seven recommendations to the government. To ensure Japan's leadership in the lunar industry, it is vital that government, industry, and academia work together to craft a unique national vision, embrace risk, and implement it steadily and strategically.

On behalf of the Council, I would like to extend my sincere gratitude to everyone who has contributed to this initiative.

Going forward, we hope to promote the development of the lunar surface industry in collaboration with diverse stakeholders in Japan and abroad, based on the Lunar Surface Industry Vision 2024, which was created with both domestic and international input.

Ultimately, our goal is to build a bridge between the lunar and Earth economies, realizing the concept of Planet 6.0 vision.

Acting Chair　Takahiro Nakamura (Midtown, Inc.)

I am grateful for the opportunity to work with so many highly ambitious people on this powerful vision of our future in space. Together with former Representative Kenji Kawamura and Representative Keitaro Ono, I have been pushing for the enactment of a Space Resources Act to help catalyze private-sector space exploration and development, including on the Moon. The bill was finally passed in the last ordinary Diet session as the Law Concerning the Promotion of Business Activities Related to the Exploration and Development of Space Resources. It is important to share a vision and timeline that all stakeholders should aim for, and then work out from there what steps to take now. I also trust that the Government will consider the views of the private sector and establish ordinances to enforce the new Act, so that our commercial space industry can achieve lift-off.

Acting Chair Kobayashi Takayuki (Member of the House of Representatives)

We have served as the Acting Chairperson of this Council with the desire to be a pioneering think tank that leads the way in expanding humanity’s sphere of existence and economy Towards a future filled with dreams and potential. Three years have passed since the publication of the "Lunar Industry Vision - Toward the Planet 6.0 Era in June 2021, during which time lunar surface development has made significant progress. In Japan, the updated Basic Plan on Space Policy released in 2023 includes a significant increase in the number of references to the Moon's surface and the term "lunar economic zone," indicating a direction to focus on lunar surface development. The "Lunar Surface Industry Vision 2024" is the result of our discussions and efforts.

The revision reflects the current situation in Japan and abroad. The development and utilization of the Moon's surface is a grand challenge for mankind, and it is essential for companies in various fields and domains to work together. In our activities based on this newly created vision, we will continue to play a role in the formation of the lunar industry ecosystem.

Acting Chair Tetsya Hanyu (Mitsubishi Research Institute, Inc.)

My interest in space exploration goes back to my childhood dream of becoming an astronaut. Now, as a member of the National Diet of Japan, I take a keen interest in space-related legislation and have been supporting the expansion of our space industry with great enthusiasm. I have long wanted to promote development of the Moon's surface, so I am delighted to have a hand in the creation of this Lunar Industry Vision. Developing the talents of the next generation is vitally important, and a lunar industry will provide many opportunities for young researchers to be involved in the space field. I would like to see, and am thrilled to learn, how the challenges in the new field of lunar surface (including Earth-Moon transportation, construction and infrastructure, information and communication, resources and energy, lunar transportation, food and biotechnology, finance and insurance, media and entertainment, and tourism) will bring about innovations in our lives on Earth. Furthermore, I believe that our experience on the Moon will give us great strength for future forays into deep space exploration of Mars and asteroids. I would like to share with all of you that Japan's strength for the future lies on the Moon. Let us work together to advance it.

Acting Chair Karen Makishima (Member of the House of Representatives)

We are very pleased to have completed the first revision of the Lunar Industry Vision in three years. During this period, the lunar industry has made steady progress. My company, ispace, attempted to land on the Moon in 2023, and had planned to make its second launch in 2024. JAXA's SLIM also successfully landed on the Moon and survived the lunar night. These are important endeavors for Japan, and we feel that they represent a major step forward in the growth of the lunar industry. In addition to the lunar landings, Japan's technological development has evolved in various fields during this period, and a wide range of technological progress has been made, including the development of spacecraft and efforts toward sustainable resource utilization. The vision compiled by the Council has paved the way for these advances.

I believe that this is also contributing in no small measure to the progress made during the past three years.

The revised vision will further enhance the social and economic value of the lunar industry, and the steady progress of the plan through the united efforts of government, industry, and academia will be the key to further progress. We are very much looking forward to playing a part in this vision and working together with our partners in Japan and abroad to pioneer the future of the lunar surface industry.

Acting Chair Takeshi Hakamada (ispace, inc.)

Lunar Industry Vision 2024 Executive Summary

In June 2021, the Lunar Industry Vision Council (hereafter referred to as the Council) published the "Lunar Industry Vision - Toward the Planet 6.0 Era -", with declarations by the industry to take the initiative in forming new industries on the lunar surface and creating innovations on Earth by returning value to Earth, and calling on the Government of Japan to work together to realize this future.

More than three years have already passed since "Lunar Industry Vision - Toward the Planet 6.0 Era -" was announced, during which there has been international progress in government-related activities, including the success of NASA's Artemis 1, DARPA's LunA-10, India's successful landing of Chandrayaan-3 on the Moon, the development of China's Chang'e program, and Japan's SLIM which achieved the world's first successful pinpoint landing on the Moon. Additionally, significant progress has also been made in private companies, most notably ispace's attempt to land on the Moon and Intuitive Machines' first successful soft landing on the Moon. Furthermore, consortiums (such as the Lunar Surface Innovation Consortium (LSIC) in the U.S. and Euro2Moon in Europe) have been working to promote lunar exploration and the creation of lunar industries, and there is a movement to seek mutual collaboration – for example the Council was approached by Euro2Moon for collaboration. As for rule making (which is a prerequisite for business), there has been movement to establish both national laws in each country and a political agreement led by the U.S., “Artemis Accord". The United Nations established a Working Group in 2023 to study international rules for space resources, and representatives from countries around the world have encouraged discussions based on a five-year work plan.

The Council has held two lunar business conferences since the release of "Lunar Industry Vision - Toward the Planet 6.0 Era -", and has worked to foster a movement toward the creation of lunar businesses by publicizing the results of the Council's deliberations and proposals to the Government of Japan. Nine Working Groups (WGs) have been formed according to the fields of interest of the member companies: "Earth-Moon Transportation", "Construction and Infrastructure", "Information and Communication", "Resources and Energy", "Lunar Transportation", "Food", "Finance and Insurance", "Media and Entertainment", and "Tourism". The WGs discussed and examined issues and solutions for the materialization and realization of lunar business, and organized them into technical, business, and legal aspects. The Council have held joint events to promote collaboration and mutual understanding with the scientific community.

As for moon-related activities other than those of the Council, the Stardust Program has been promoted by relevant ministries and agencies, and the Basic Plan for Space Policy revised in June 2023 includes a significant increase in the use of the keyword "lunar surface" and the phrase "lunar economic zone". The Moon has been attracting increased attention in Japan. In addition, the "Space Technology Strategy" released in March 2024 identifies "energy technology", "lunar communications and positioning technology", "lunar resource development/utilization technology", and other technologies that will lead to lunar industries as important technologies for "lunar exploration and development". The "Space Strategy Fund" has also begun soliciting applications for its support with respect to the development of related technologies. In addition to government activities, each conference which the Counsil held was attended by more than 300 people, and the Moon Village Symposium held in Kurashiki in December 2023 was attended by 180 people, despite being held outside the Tokyo metropolitan area. This confirms the growing interest in the lunar business. Further, more than 270 companies have expressed interest in the lunar industry by participating in related communities and participating in or supporting government projects or private sector activities. This is a significant increase since the vision was announced.

Since the release of "Lunar Industry Vision - Toward the Planet 6.0 Era", many matters related to the lunar industry, including the matters not included in the six declarations and seven recommendations set out in "Lunar

Industry Vision - Toward the Planet 6.0 Era", have been realized or materialized. The lunar business has become more organized and detailed.

In response to major changes in the external environment, including the changes in policies (including the Space Basic Plan, the Space Technology Strategy and the Space Strategy Fund), the improved resolution of the lunar business through discussions in the WGs within the Council and the progress in collaboration with the scientific community and overseas communities, the Council has decided to revise the "Lunar Industry Vision - Toward the Planet 6.0 Era" and publish a new "Lunar Industry Vision 2024". This newly released "Lunar Industry Vision 2024" is a compilation of seven declarations by industry and seven recommendations to government (some of which are new and some of which are continued from the previous vision), based on the status of the declarations and recommendations set out in the previous vision and the results of discussions and deliberations within the Council. Similar to the stance taken in the "Lunar Industry Vision - Toward the Planet 6.0 Era", this vision is not intended to ask the government to provide all the funds necessary for the realization of the lunar industry, but rather to ask the government to improve the business environment, including measures based on Article 16 of the Basic Act on Space Policy, "Promotion of Space Development and Utilization by Private Business Operators," for the industry to implement and develop the lunar business autonomously.

Seven Declarations by Industry:

Declaration 1. [Continuation]

Moving toward an era of private sector-led lunar activity, we will identify areas where, in relation to government programs or private sector activities, the industry's strengths are required and/or applicable. In doing so, we will improve our technology and capabilities and increase our threshold for risk in order to lead the world in the implementation of lunar orbit and lunar surface businesses.

Declaration 2. [Continuation (with the underlined part added)].

We will use the Moon as a platform to validate technologies and social systems that return value in the form of innovation and advancement of society on Earth and <u>in Earth orbit</u>.

Declaration 3. [Continuation]

In the era of private sector-led lunar activity, we will conduct lunar business for the private sector, as well as domestic and foreign governments, across various industrial categories such as transportation (Earth-Moon, lunar surface); information and communication; media and contents; resources and energy; construction and infrastructure; food and biotechnology; finance and insurance; tourism; and others.

Declaration 4. [New]

In order to lead the world in establishment of the basic infrastructure required for lunar surface development in the next 10 - 20 years (with the private sector taking initiative), we will soon conduct technology demonstrations on ground, in low earth orbit (including at a commercial space station) and/or on the Moon with respect to underlying technologies for the infrastructure (such as "transportation (Earth-Moon, lunar surface)", "resources and energy" and "information and communication") and the necessary systems.

Declaration 5. [New]

We will ensure that the private sector will take the lead in acquiring, analyzing, and providing opportunities to utilize lunar data on resources and the lunar surface, which will serve as the basis for planning and reviewing all lunar surface activities, and we will then utilize it for the Government's and private sector's respective exploration and development of resources, transportation on the Moon and design of the basic infrastructure on the Moon.

Declaration 6. [Integrate and continue]

We will identify specific rules and legal frameworks necessary to form a globally competitive industrial base, which highlight the positive effects if they are enacted and the risks if they are not enacted. We will also proactively develop and disseminate codes and norms to be followed by industry in the development and utilization of the Moon (e.g., adherence to environmental protection, sustainable development, and peaceful use of the Moon, etc.).

Declaration 7. [New]

We aim to create a virtuous circle through the synergy effect of cooperation between the scientific community and industrial community which are both aiming for the Moon. We will work on sustainable lunar development and build an industrial base, through collaboration among communities (rather than one-off projects) which includes but not limited to the following collaboration:

- the knowledge and data of the scientific community or the development of observation instruments will help build the lunar industry;
- missions and services by the private sector, whose technologies and capabilities have been improved through participation in scientific projects, will expand research opportunities and promote advancement and diversification of research by the scientific community; and
- the private sector will participate in new scientific projects.

Seven Recommendations to the Government:

Recommendation 1. [Continued with additions of underlined parts and changes to underlined parts].
Governments should widely monitor the trends of technological and business development on the Moon by private companies in various industries and assume the procurement of private services, as standard practice, to create a lunar industrial ecosystem. This should include transportation to the lunar surface and lunar orbit, exploration, infrastructure construction, and other activities. To this end, the policy significance of the Moon and lunar industry should be clarified with a view to its linkage with existing industries on the Earth and in Earth orbit and the government's plans and policies for lunar activities, such as its involvement in the Artemis program, should be organized in a visible manner, in each case to enhance the foresight of the private sector.

Recommendation 2. [Continuation]
In order to reduce the cost of access to the Moon, the government should supply opportunities, utilizing both public and private missions, for the transportation of payloads to the Moon necessary for commercial lunar activity. For government missions, the government should provide the private sector with rideshare opportunities by offering the surplus payload capacity of the launch vehicle. For private missions, the government should utilize transportation opportunities to the Moon as a service provided by the private sector.

Recommendation 3. [Continued (with the addition of the underlined part)].
The government should, at its risk, improve the environment for the acceleration of lunar-related business development. In doing so, the government should establish programs and opportunities for the creation of new businesses and the introduction of entrepreneurs into the lunar industry; implement programs to promote the flow and transfer of human resources, knowledge and technology; build a simulated test environment (e.g., a digital twin) using the latest lunar surface data which will be measured in the field; and develop a ground communication infrastructure for deep space.

Recommendation 4. [New]
In order to quickly realize the construction of the lunar surface infrastructure (such as transportation, resources and energy, information and communications, etc.) with the private sector taking the initiative, the government should support ground demonstrations in special zones with relaxed standards for communication and radiation and others, and provide opportunities for initial demonstrations in low earth orbit and on the Moon's surface.

Recommendation 5. [New]
In addition to data acquired by the government, the government should support the acquisition and analysis of lunar data by the private sector and actively utilize it to further promote lunar activities such as lunar resource exploration and development, transportation on the Moon, and design of basic infrastructure. To this end, the government should support the development of sensors and other technologies and procure private-sector services.

Recommendation 6. [Continuation]
The Government of Japan should promptly establish necessary systems, guidelines and standards, etc., in order to boost the global competitiveness of the Japanese private sector, and work with the international community to establish rules and standards for international commercial activities (e.g., communication bandwidth, construction standards, safety zones, and codes and norms to be followed by industry, etc.). Through these activities, Japan may be recognized as a country that is proactive in supporting lunar business, thereby attracting foreign companies, and becoming a center of the world's most advanced information, while controlling the export of information abroad.

Recommendation 7. [New (with the underlined part continued)].
The government should clarify in policy that collaboration and complementarity between the scientific community and the industrial community have various effects on both scientific exploration, including J-Moon's Big Three, and the formation and enhancement of the industrial ecosystem. In addition, in order to enhance the synergistic effects of collaboration between lunar science and lunar industry, the government should take measures to establish a platform for collaboration between the two communities, develop cooperative programs, and promote the use of private facilities and services in scientific programs.
<u>At the same time, these efforts should be linked to the development of the next-generation workforce and higher education.</u>

As mentioned above, policy attention to lunar surface development has increased significantly since the previous vision was released, and the industry is encouraged by the fact that the government and the industry are on the same page. The Moon's surface is still a blue ocean area compared to Earth orbit, which is a red ocean where the competition among countries is fierce, and it is positioned as a frontier area for the next generation. Japan is ahead of other countries in all aspects of policy, science, and industry, including, in terms of policy, the enactment of the Space Resources Act, the formulation of the Space Technology Strategy and the establishment of the Space Strategy Fund; in science, the successful SLIM's pinpoint landing and overnight survival; and in industry, the commencement by more than 270 private companies of lunar industry related activities. In comparison, some of the R&D results of the Stardust Program have not been carried over to subsequent programs. In order for Japan to utilizing our current position and lead as a front runner, and to create a "lunar industrial revolution" led by the private sector on the lunar surface, it is essential to further strengthen activities related to the lunar surface.

This vision is a statement of the industry's determination to take the initiative in forming new lunar industries and creating innovation on Earth through returning value to the Earth, as well as a request to the government to work together to realize this future. This vision should be reviewed in response to changes in circumstances, and hence will be updated as necessary.

[Reference]

Details by area of the seven declarations by industry

Item	Area /field	Details/Individual Assignments
Declaration 1. Strengthening the foundation of the private sector-led lunar industry	Whole	✓ Accelerate the development of technologies and businesses through self-investment by taking risks
	Transportation (Earth-Moon)	✓ Accumulation of technologies related to transportation (Earth-Moon)
	Construction and Infrastructure	✓ Organize each company's area of expertise
	Information and Communication	✓ Establishment and operation of ultra-long distance communication systems ✓ Establishment of hybrid optical/radio communications in the vicinity of each of the Earth and the Moon
	Resources and Energy	✓ Acquisition of technologies related to resource extraction ✓ Acquisition of technologies for power generation, transmission, etc.
	Transportation (lunar surface)	✓ Development of a lunar transportation vehicle ✓ Development of life support systems ✓ Development of unmanned operation management system
	Food	✓ Advanced Development ✓ Planning of promotion of construction, design and operation in each case in respect of demonstration fields such as a lunar base simulation facility, and conducting ground demonstrations of the developed integrated system. ✓ Demonstration in space
	Finance and Insurance	✓ Preparation of standard terms and conditions for general insurance policy for lunar development
	Media and Entertainment	✓ Development of facilities and contents to simulate the lunar surface
	Tourism	✓ Build momentum for lunar business
Declaration 2. Returning innovation from the Moon to the Earth	Whole	✓ Returning Innovation from the Moon to the Earth
Declaration 3. Conducting lunar business for the private sector, as well as domestic and foreign governments	Whole	✓ Conducting lunar business for the private sector, as well as domestic and foreign governments in an era when the private sector takes the lead.
Declaration 4. Conducting technical demonstrations on the lunar surface and in lunar orbit	Whole	✓ Promote world-leading empirical R&D of private-sector technologies ✓ Promote private-sector-led infrastructure construction and provide services to customers
	Transportation (Earth-Moon)	✓ Demonstration of basic technologies for lunar lander/payload operations on the lunar surface
	Construction and Infrastructure	✓ Demonstration using unmanned construction technology

	Information and Communication	✓ Demonstration of high-efficiency, high-data-rate communication technology for ultra-long-distance communications ✓ Demonstrations of constellations in Earth and lunar orbits
	Resources and Energy	✓ Demonstration on the lunar surface of fundamental technologies in lunar water resource plant system
	Transportation (lunar surface)	✓ Demonstration of lunar transportation vehicles, life support systems, and unmanned vehicles management systems
	Food	✓ Demonstration of food supply systems and underlying technologies at a simulated lunar base and in low earth orbit ✓ Demonstration of food supply systems and underlying technologies on the lunar surface

Item	Area /field	Details/Individual Assignments
Declaration 5. Promote acquisition and utilization of monthly data	Whole	✓ Development of proactive and continuous lunar data acquisition and analysis ✓ Development of simulation using lunar data
	Transportation (Earth-Moon)	✓ Developing needs by promoting the utilization of lunar data
	Construction and Infrastructure	✓ Promoting acquisition and analysis of basic data for the establishment of building standards on the lunar surface
	Resources and Energy	✓ Acquisition and analysis of water and metals resource data
	Media and Entertainment	✓ Development of contents using lunar data
Declaration 6. Establishment of rules and framework for commercial activities on the Moon	Whole	✓ Embodiment of commercial activities on the Moon and legal risk analysis.
	Construction and Infrastructure	✓ Leading the way in advocating the concept of international lunar building standards
	Resources and Energy	✓ Conceptual design of a lunar water resource plant system and establishment of a business model
Declaration 7. Promote collaboration between lunar science and lunar industry	Whole	✓ Promote mutual understanding between the scientific and industrial communities through collaboration ✓ Planning and design of cooperative missions by the scientific community and private sector

Details by area of the seven recommendations to the government

Item	Area /field	Details/Individual Assignments
Recommendation 1. Procurement of private sector services; clarification of the policy significance of the Moon and lunar industry to improve predictability	Whole	✓ Launching industrial promotion policies by supporting private-sector technological and business development surrounding the moon
	Transportation (Earth-Moon)	✓ Launch of R&D programs to take advantage of the technological capabilities possessed by the private sector
	Construction and Infrastructure	✓ Government procurement of unmanned construction technology services
	Information and Communication	✓ Launch of R&D program to develop high-efficiency, high-data-rate communication technology for ultra-long distance communication ✓ Launch of demonstration program for constellations in the earth orbit and the lunar orbit
	Resources and Energy	✓ Clarification of policies for fostering and promoting technologies related to resource extraction, power generation and transmission, etc.
	Tourism	✓ Clarification of policy to ensure manned transportation to the Moon
Recommendation 2. Securing access opportunities to	Whole	✓ Provide transportation opportunities for goods necessary for private sector to conduct lunar commercial activities

the Moon		
Recommendation 3. Creating an environment to accelerate private sector business development	Whole	✓ Launch of programs and venues for creating new businesses and entrepreneurs in the lunar industry ✓ Implementation of programs to promote mobility and transfer of human resources, knowledge, and technologies ✓ Construction of a simulated test environment (e.g., digital twin) using the latest lunar data ✓ Development of ground communication infrastructure for deep space
Recommendation 4. Creation of opportunities for technology demonstration on the lunar surface and in lunar orbit	Whole	✓ Creation of opportunities for technology demonstration on the lunar surface and in lunar orbit ✓ Promote and use private sector initiative to build infrastructure
	Transportation (Earth-Moon)	✓ Creating opportunities for demonstration on the lunar surface of basic technologies for lunar lander/payload operations

Item	Area /field	Details/Individual Assignments
	Construction and Infrastructure	✓ Securing demonstration opportunities through government procurement of unmanned construction technology services
	Information and Communication	✓ Launch of R&D program to develop high-efficiency, high-data-rate communication technology for ultra-long distance communication ✓ Launch of demonstration program for constellations in the earth orbit and the lunar orbit
	Resources and Energy	✓ Creation of demonstration opportunities on the lunar surface for fundamental technologies in lunar water resource plant system
	Transportation (lunar surface)	✓ Creation of opportunities to demonstrate lunar transportation vehicles, life support systems, and unmanned operations management systems
	Food	✓ Construction of a simulated lunar base facility, demonstration of system integration, and demonstration of technologies in low earth orbit and on the lunar surface
Recommendation 5. Active purchase of lunar data services	Whole	✓ In addition to data acquired by the government, support acquisition and analysis of lunar data by the private sector and actively utilize it ✓ Support the development of sensors and other technologies and purchase private services
Recommendation 6. Development of rules and framework for commercial activities on the Moon	Whole	✓ Legal risk analysis and legislation of commercial activities for rulemaking ahead of the world
	Transportation (Earth-Moon)	✓ Develop rules for coordinating lunar landing sites ✓ Clarification of the scope of responsibility of the business, the customer and the government
	Construction and Infrastructure	✓ Establishment of international rules ✓ Development of technical standards and guidelines for buildings on the Moon
	Information and Communication	✓ Establishment of mechanism and rules for radio frequency coordination on the lunar surface
	Resources and Energy	✓ Establishment of national laws and international laws on the use of land and resources on the Moon
	Transportation (lunar surface)	✓ Establishment of rules regarding the proprietary right, right of possession and right of use when land is cleared on the Moon ✓ Establishment of rules for transporting goods and people on the lunar surface
	Food	✓ Establishment of rules for safety and health management ✓ Develop regulations for planetary protection in anticipation of manned activities
	Finance and Insurance	✓ Consideration of government compensation system ✓ Establishment of rules etc. for compensation for damages between private companies in outer space and on the Moon
	Media and Entertainment	✓ Establishment of guidelines etc. for promoting secondary use of image data
	Tourism	✓ Establishment of rules for lunar and space travel

Recommendation 7. Promote collaboration between lunar science and the lunar industry	Whole	✓ Clarify policy significance of complementarity and synergistic effects between the scientific community and the industrial community ✓ Policy support for planning of science mission that leverages private sector mission opportunities and private sector infrastructure and services ✓ Creating an environment for expanding moon science findings and data that are easy for the private sector to use

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1. Introduction.

Key points of this chapter

- Planet 6.0, the key point of the "Lunar Industry Vision - Toward the Planet 6.0 Era" (hereinafter referred to as the previous vision), and market creation through private sector-led value and public-private sector collaboration
- Recognition and evaluation of the achievement of the previous vision's resolutions and recommendations
- Positioning of the Lunar Industry Vision 2024

1.1 Previous Vision Points

The "Lunar Industry Vision" released in June 2021 declared the commitment of the private sector and made recommendations to the government regarding actions that should be taken by the public and private sectors to lead the world in building a new industry that brings together Japan's industrial strengths, with Planet 6.0, a new social vision, at its core.

1.1.1 Planet 6.0, a new social vision

In the "Lunar Moon Industry Vision - Toward Planet 6.0 Era", the Lunar Moon Industry Vision Council proposed "Planet 6.0" as a new concept of society following Society 5.0, which will be a common perspective for further promotion of private sector-led lunar exploration and utilization.

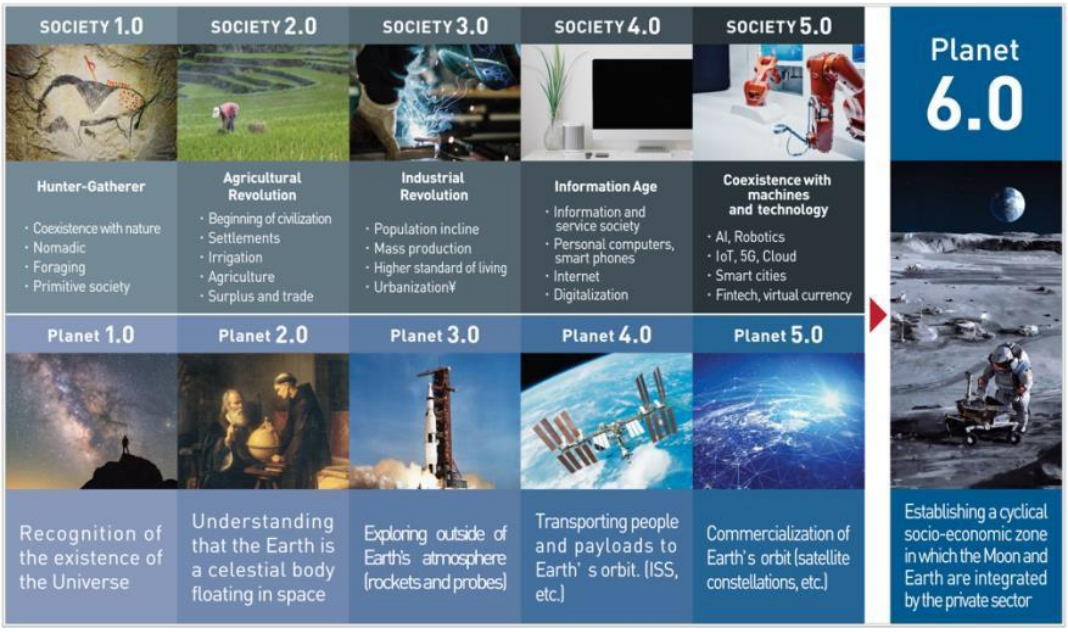


Figure 1: "Planet 6.0," a social vision for a new era
(Source: Prepared by the Lunar Industry Vision Council)

Planet 6.0 is a concept that aims to build a recycling-oriented social economy that integrates the Earth and space, including other celestial bodies, in light of the fact that the sphere of human social and economic activity has already extended into Earth orbit and will expand to the Moon and other celestial bodies beyond the Moon in the near future, as the relationship between humans and space has changed over history. The concept aims to build a recycling-oriented social economy in which the Earth and the universe, including other celestial bodies, are integrated.

Planet6.0 aims to create a new market on the Moon through human activities that extend beyond the Earth, and to create a recycling society in which technological and social innovations fostered there will return

high value to society and industry on Earth. The worldview of robotics, energy technology, and manned space technology that humans will create by making full use of technology in space and on the Moon will be based on the concept of automation, energy conservation, and the creation of a sustainable society that returns high value to Earth's society and industry.

The SDGs are expected to provide a means of solving global social issues that are common to the concepts of the SDGs, such as the globalization of society, acceleration of research in healthcare and life sciences, and so on.

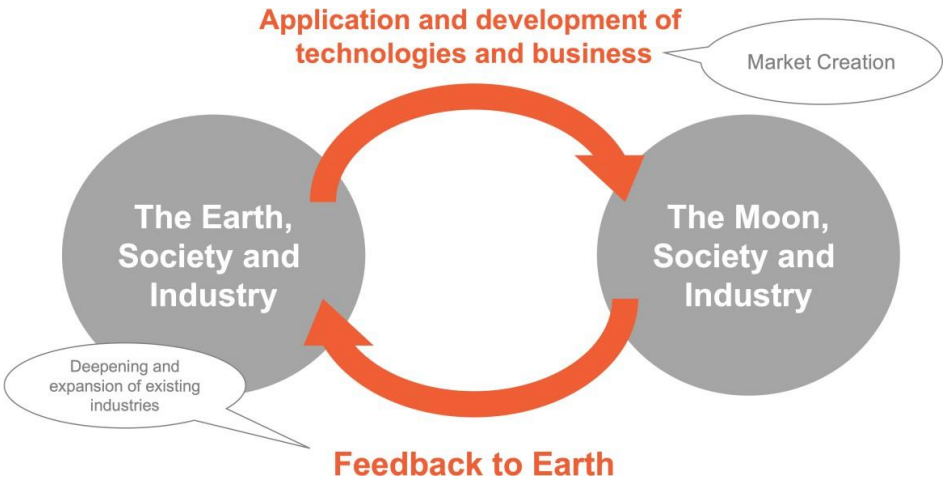


Figure 2: Planet 6.0 depicts the Earth-monthly cycle
(Source: Prepared by the Lunar Industry Vision Council)

1.1.2 Private sector-led value and market creation through public-private partnerships

The previous vision was compiled as a statement of industry's determination to take the initiative in forming new industries in lunar space and creating innovation on Earth through value return, and as a request to the government to work together to realize this future.

The private-sector-led movement is expected to grow at an accelerated pace through mutual collaboration between the public and private sectors. As the private sector invests independently and builds up its technological capabilities and track record, government procurement of services from the private sector will serve as a catalyst to further boost the private sector's capabilities. The private sector can provide services that meet the expectations of the government and stimulate further demand, forming a virtuous circle between the public and private sectors. Such mutual contributions by the public and private sectors will accelerate the private sector's activities explosively and bring about a "lunar industrial revolution," a revolution that will create new industries on the Moon's surface.

The Artemis mission is not the only possible trigger for this industrial revolution. Industry's commitment to the ongoing activities of the scientific community, such as the construction of a lunar observatory, detailed exploration of the lunar surface, and deep space exploration from the lunar surface and lunar orbit, will also be an area that will support the creation of new industries. Expanding the scope of scientific research through collaboration with the private sector, rather than relying solely on government initiatives, is not only academically significant, but also has great significance from the perspective of fostering the next generation of researchers and education.

For the lunar industrial revolution, it is essential for the private sector itself to actively promote lunar missions, demonstration projects, and technological development, as well as to build momentum. The private sector should form a market through its own investments and actions, and contribute not only to the Business to Government (BtoG) and Business to Business (BtoB) markets, but also to the Business to Consumer (BtoC) market for the general public, the scientific community, and the solution of social issues. We will strive to build and expand not only the public demand market (BtoG: Business to Government) and private demand market (BtoB: Business to Business), but also the consumer market (BtoC: Business to Consumer) and the market contributing to the scientific community and solving social issues (BtoS: Business to Society/Science).

PwC estimates that the market size of the lunar industry formed by these activities will grow to a cumulative $130.1B between 2036-2040

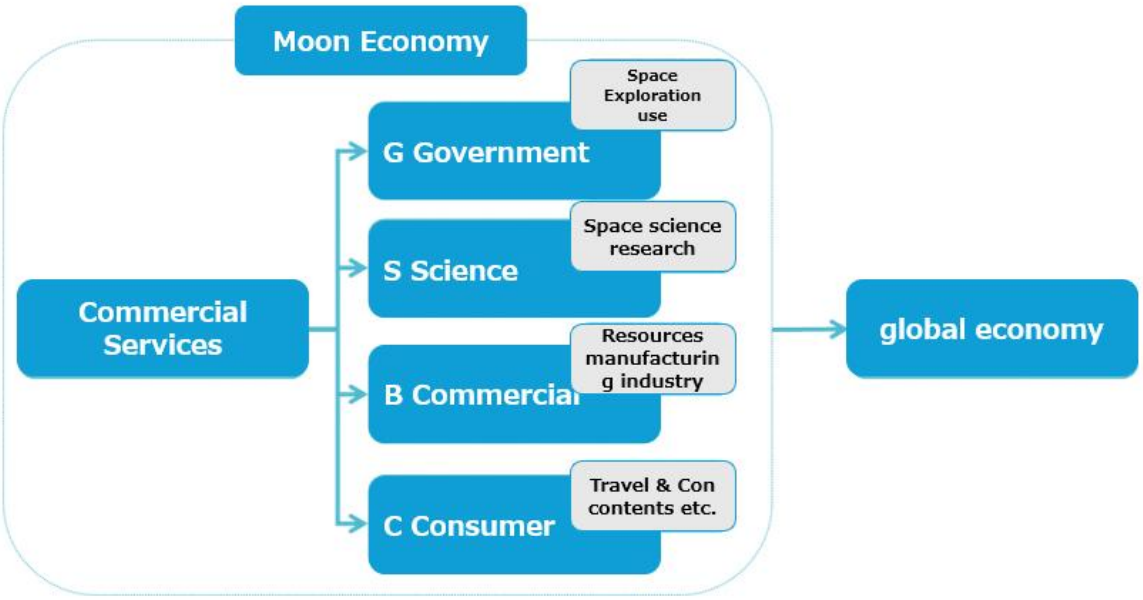
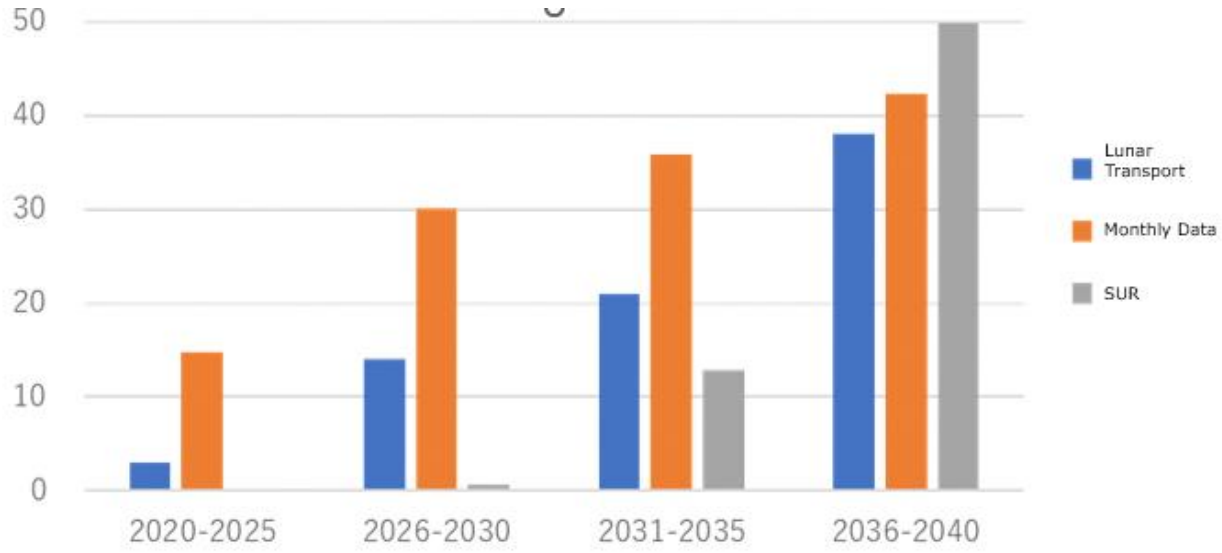


Figure 3: Markets and Service Customers in the Industrial Value Chain
(Source: Prepared by the Lunar Industry Vision Council)



- ✓ 2020-2025, the total market size of the lunar industry is $17.7B, including $3.0B for lunar transportation, $14.7B for lunar data, and $0B for SUR.
- ✓ The total market size of the lunar industry grows to $130.1B in 2036-2040. The breakdown is as follows: lunar transportation market $38.0B, lunar data market $42.3B, and SRU market $49.8B.

Figure 4: Market Size of Lunar Industry Assuming Expansion of Private Demand Market
(Source: PwC)

It is desirable for the government to support the private sector in response to the challenges of Japanese industry, and to establish a policy system to form an industrial base that is competitive in the world.

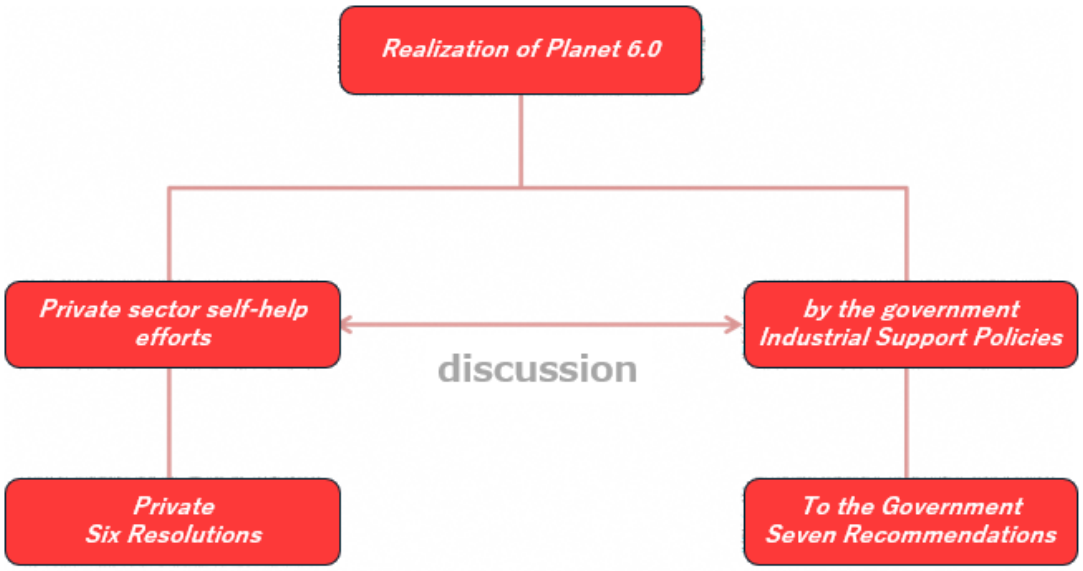


Figure 5: Coordination of private sector initiatives and government industrial support measures
(Source: Prepared by the Lunar Industry Vision Council)

1.2 Achievement of previous vision resolutions and recommendations

Since the release of the "Lunar Industry Vision," many items related to the lunar industry have been realized, materialized, and detailed, including the six resolutions and seven recommendations of the Vision. In addition, there have been major changes in the external environment, such as changes in policies, including the Space Basic Plan, the Space Technology Strategy, and the Space Strategic Fund; improvements in the resolution of the lunar business through discussions in the WGs within the Council; and progress in cooperation with the scientific community and overseas communities.

Therefore, we will summarize our recognition and evaluation of the degree of achievement of the six resolutions and seven recommendations set forth in the same vision.

1.2.1 Achievement of the Six Resolutions

6 The recognition and evaluation of the level of achievement of each of the three resolutions is summarized below.

We will find places where the power of industry can be sought/utilized in an age when the private sector takes the lead, and we will take risks ourselves to improve our technology and capabilities so that we can be the world's pioneers in business development.

Achievement rating: [Progress].

The Stardust Program and the Space Technology Strategy have made progress in clarifying where industry's capabilities are required and where they can be utilized. In addition, some private companies are taking risks to improve their technologies and capabilities ahead of the rest of the world, such as ispace's challenge to become the first private company in the world to land on the moon if successful, and Takasago Thermal Engineering's challenge to become the first company in the world to conduct water electrolysis on the moon. Based on the above, we evaluate that progress is being made in this resolution.

On the other hand, the contents of this resolution do not end at the present time, but should be continued in the future, and it is our policy to continue it in the Lunar Industry Vision 2024.

Determination 2. Utilize the lunar surface as a site for technological and social demonstrations to create new technologies and social systems, as well as to bring innovation to the Earth by giving back from the Moon to existing industries on Earth.

Evaluation of achievement: [Some progress].
The success of SLIM, a government program, has advanced the technology demonstration. In addition, the future plans for ispace's M2 and

JAXA's LUPEX will further advance the technological demonstration. On the other hand, the project has not yet led to the creation of new technologies and social systems, the return of existing industries to the earth, or innovation on the earth, and is therefore considered to be only partial progress.
As with Decision 1, this is not something that will end at this point in time, but is something that should be continued in the future.

Determination 3. Specifically list the rules and legal systems that are necessary to develop business ahead of the rest of the world and indicate the effects if enacted or the risks if not enacted.

Evaluation of achievement: [Some progress].
Legal system was set as one of the perspectives for consideration in the WG activities of the CIPP, and the rules and legal systems necessary for business development were organized. On the other hand, the study of risks in the event that they are not enacted is not sufficient, which is evaluated as partial progress.
As with Decisions 1 and 2, this is not something that will end at this point, but something that should continue to be addressed in the future.

Decision 4. develop and disseminate a code/codes that industry should follow in developing and utilizing the Moon (e.g., adhere to environmental protection and peaceful use of the Moon, develop and utilize the Moon in a sustainable manner with a trans-terrestrial perspective, etc.)

Achievement rating: [Not achieved
While the study of this point of view has not been completed, it is an important issue for the industry to consider, and therefore, it should be continued in the Lunar Industry Vision 2024 as an issue to be addressed in the future.

In an era when the private sector is taking the lead, we will provide the Moon business to private companies or domestic and foreign governments in various fields such as "transportation (Earth-Moon, Moon)," "information and communication," "media and contents," "resources and energy," "construction and infrastructure," "food and biotechnology," "finance and insurance," "tourism," and so on. We will conduct lunar business for private companies and domestic and foreign governments in a variety of fields, including "media and communications," "resources and energy," "construction and infrastructure," "food and biotechnology," "finance and insurance," and "tourism.

Evaluation of achievement: [Some progress].
The resolution of lunar business has been improved through the WG activities (see Chapter 4 for details) On the other hand, only a small number of companies can be said to be engaged in lunar business at this point, which is evaluated as partial progress.
Since this is also a matter that should be addressed in the future, it is our policy to continue it in the Lunar Industry Vision 2024.

Resolution 6. As a flagship to arouse public interest in the Moon, plan and execute Moon missions (e.g., sample return of lunar water ice, experience of piloting lunar exploration robots and tactile transmission through the use of Earth-Moon real-time interactive communications, etc.) utilizing the opportunities provided by the Osaka/Kansai Expo.

Evaluation of achievement: [Some progress].
Although the Moon mission was not planned, the Lunar Moon Industry Vision Council applied for the Expo '70 Co-Creation Challenge and made concrete efforts, which was evaluated as partial progress.
Although we will continue to search for opportunities to exhibit private sector initiatives at Expo 2010 Osaka/Kansai, this resolution will not be carried over to the Lunar Industry Vision 2024, as we have already reached the level of concrete initiatives.

The above information is summarized in the table below.

Contents	Recognition and evaluation
Determination 1. Industry's strength is required for an era in which the private sector takes the lead/activities We will find places where we can take risks and improve our technology and capabilities to be the first in the world to develop business.	period [Progress].
The Moon's surface will be utilized as a site for technological and social demonstrations, and new technological and social systems will be developed. The Moon will also bring innovation to the Earth by creating a new system and returning it to the existing industries on the Earth.	△ Partial progress
Determination 3. rules and legislation needed to do business ahead of the rest of the world The degree of enforcement will be specified, and the effect if enacted or the risk if not enacted will be shown.	△ Partial progress
Decision 4. norms/codes to be followed by the industry in developing and using the Moon (e.g., adherence to environmental protection and peaceful use of the Moon, sustainable development and use of the Moon from a trans-terrestrial perspective, etc.) and disseminate them.	× [Not achieved].
In an era when the private sector has taken the lead, we will continue to work with the private sector and domestic and foreign governments in a variety of fields, including "transportation (Earth-Moon, Moon)","information and communications,""media and content,""resources and energy," "construction and infrastructure,""food and bio-food,""finance and insurance," and "tourism," to develop and promote the private sector's role in these fields. private companies and domestic and foreign governments in a variety of fields, including We will do lunar business against the Prefecture.	△ Partial progress
Resolution 6. As a flagship to arouse public interest in the Moon, plan and execute Moon missions (e.g., sample return of lunar water ice, experience of piloting lunar exploration robots and tactile transmission through the use of Earth-Moon real-time interactive communications, etc.) utilizing the opportunity of Expo 2010 Osaka/Kansai.	△ Partial progress

1.2.2 Achievement of the seven recommendations

The following is a summary of the recognition and evaluation of the level of achievement for the recommendations as well as the resolutions.

Recommendation 1: Governments should share the value of innovation brought about by commercial space utilization and make procurement of private services a prerequisite for the formation of an industrial ecosystem. The government should assume the procurement of private sector services to create an industrial ecosystem, including transportation to and from the Moon and lunar orbit, exploration, infrastructure construction, and other activities. To this end, government plans for lunar activities, including the ARTEMIS program, should be organized in a visible manner to enhance private sector foresight.

Evaluation of achievement: [Some progress].

The government's visualization of lunar-related activities has been greatly enhanced by the Space Basic Plan and the Space Technology Strategy, and the predictability of the private sector has been improved. On the other hand, the procurement of private-sector services is still a long way off, although some studies are underway in areas such as transportation. Overall, the report evaluates the progress as partial.

Since the contents of this proposal are matters that should continue to be considered in the future, it is our policy to continue them in the Lunar Industry Vision 2024.

Recommendation 2. that the government be the provider of transportation opportunities for the private sector to transport supplies needed for lunar commercial activities, utilizing lunar missions conducted by the public and private sectors respectively, in order to reduce the cost of access to the Moon. For government missions, provide carpooling opportunities to the private sector by utilizing excess space on

lunar transport rockets. For private missions, to utilize as a service the transportation opportunities to the Moon's surface and lunar orbit provided by the private sector.

Evaluation of achievement: [Some progress].

Transportation to the Moon's surface is a major bottleneck in the development of the lunar surface industry, and reducing the cost of access to the Moon's surface is a life-and-death issue for the development of the industry. As mentioned in the achievement evaluation of Proposal 1, the use of private transportation services is being considered, but there is still a need to explore the possibility of providing carpooling opportunities for government missions.

The overall evaluation is partial progress, as there has been no progress in materializing the discussion.

Since the contents of this proposal are matters that should continue to be considered in the future, it is our policy to continue them in the Lunar Industry Vision 2024.

Recommendation 3: The government should promote the design of appropriate institutions to accelerate private sector investment in lunar business, while leveraging existing industrial policies as appropriate. In addition to the promotion of R&D and player accumulation through a sandbox, and an environment that encourages investment in companies that take risks and challenge the lunar business (e.g., capital gains tax breaks for investments in lunar business companies, promotion of use of non-financial information of companies that comply with the Code/Code for Sustainable Lunar Development, etc.), various measures (e.g.), as well as various measures (e.g., R&D tax breaks, funds, special zones, cooperation with interested local governments, etc.).

Evaluation of achievement: [Some progress].

We recognize that no new institutional design or utilization of existing industrial policies to accelerate private sector investment in lunar business was made. On the other hand, the establishment of the Space Strategic Fund, which also covers lunar surface development technologies, is a significant change, and we regard it as a partial progress.

Since the realization of the contents of this proposal is important for the advancement of lunar business activities, it is our policy to revise this proposal based on the latest situation, integrate it with other proposals, and continue it in the Lunar Surface Industry Vision 2024.

Recommendation 4: The government should work to create an environment to accelerate private sector business development related to lunar surface business. The government should also work on launching programs and venues for creating new lunar industry businesses and producing entrepreneurs; implementing programs to promote the flow and transfer of human resources, knowledge, and technology; building a platform for a simulated environment (e.g., digital twin) using lunar surface data; and designing lunar exploration projects in collaboration with the scientific community and industry-academia. In addition, these efforts should be linked to the development of next-generation human resources and higher education.

Achievement rating: [Not achieved

While there are programs and human resource development programs for the entire space program, we are aware that there is no such program specific to the lunar surface. However, it is noteworthy that consideration of the transfer of SLIM technology to the private sector has been initiated.

In order to realize the Moon business, it is increasingly important to promote the transfer of human resources, knowledge, and technology owned by the government and conventional space companies, to develop a simulated test environment, and to complement and develop each other through collaboration between science and industry. The policy will be continued in the Lunar Industry Vision 2024.

The Government of Japan should promptly develop the Ministerial Ordinance on the Space Resources Act and other necessary systems, guidelines, standards, etc., so that Japanese private companies can gain a competitive advantage, and work with the international community to develop rules to ensure international commercial activities (e.g., communication bandwidth, construction standards, biological introduction, safety zones, etc.). etc.). Through these activities, the country should increase its recognition as a country that is active in supporting lunar surface businesses, thereby attracting a concentration of foreign companies, and become a center for the world's most advanced information, while paying attention to the outflow of information to overseas.

Evaluation of achievement: [Some progress].

The United Nations has established a Working Group on Space Resources, and discussions in this field are progressing, in which Japan is also participating. On the other hand, Japan has not gained recognition as a country actively supporting lunar business, and is lagging behind Luxembourg and other countries.

The formation of international rules is extremely important for the advancement of lunar business activities,

and therefore, the policy will be continued in the Lunar Surface Industry Vision 2024.

As a flagship to arouse public interest in the Moon, the government should cooperate with the private sector to realize Moon missions (e.g., sample return of lunar water ice, experience of piloting lunar exploration robots and tactile transmission using real-time Earth-Moon bi-directional communications, etc.), utilizing the opportunities provided by Expo 2005 Osaka/Kansai.

(2) The following is a list of the items that are to be considered for the project.

Achievement rating: [Not achieved

Although a space-themed pavilion will be prepared, a moon mission in cooperation with the private sector has not yet been realized, which is unfortunate.

As with Decision 6, this recommendation will not be carried over to the Lunar Industry Vision 2024, as it has already reached the level of concrete initiatives.

Recommendation 7: The public and private sectors should share the fact that measures to accelerate the development of these lunar industries will provide policy benefits to lead the international community and help solve global issues (e.g., contributing to the SDGs, building a recycling-oriented society, etc.) In addition, from the perspective of economic security, attention should be paid to the strategic indispensability of the technologies possessed by each company engaged in lunar business.

Evaluation of achievement: [Some progress].

The autonomy perspective is also mentioned in the space technology strategy, and the importance of the technology held by each company planning lunar business is recognized, which is evaluated as partial progress.

While the content of this proposal is important, it will not be incorporated into the Lunar Industry Vision 2024, as some of the issues to be addressed on Earth are already covered in other proposals.

The above information is summarized in the table below.

Contents	Recognition and evaluation
Recommendation 1: Governments should share the value of innovation brought about by commercial space utilization and make procurement of private services a prerequisite for the formation of an industrial ecosystem. The government should share the value of innovation brought by commercial space utilization and assume the procurement of private services for the creation of an industrial ecosystem. To this end, government plans for lunar activities, including the ARTEMIS program, should be organized in a visible manner to enhance private sector predictability.	△ Partial progress
Recommendation 2. that the government be the provider of transportation opportunities for the private sector to transport supplies needed for lunar commercial activities, utilizing lunar missions conducted by the public and private sectors respectively, in order to reduce the cost of access to the Moon. For government missions, provide carpooling opportunities to the private sector by utilizing excess space on the lunar transport launch vehicle. For private missions, transportation opportunities to the Moon's surface and lunar orbit provided by the private sector. as a service.	△ Partial progress
Recommendation 3: The government should promote the design of appropriate institutions to accelerate private sector investment in lunar business, while leveraging existing industrial policies as appropriate. In addition to the promotion of R&D and player accumulation through a sandbox, and an environment that encourages investment in companies that take risks and challenge the lunar business (e.g., tax breaks on capital gains from investments in lunar business companies, promotion of the use of non-financial information of companies that comply with codes/codes for sustainable lunar development, etc.), various measures (e.g., tax breaks for R&D, tax breaks for basic research, etc.) should be designed. Tax breaks for research and development, basic (money, special zones, cooperation with interested municipalities, etc.).	△ Partial progress

Recommendation 4: The Government of Japan should work to improve the environment to accelerate the private sector's business development related to the lunar surface business. The government should establish programs and venues for the creation of new businesses and entrepreneurs in the lunar surface industry; implement programs to promote the flow and transfer of human resources, knowledge, and technology; establish a platform for a simulated environment (e.g., digital twin) using lunar surface data; and develop lunar exploration projects in collaboration with the scientific community and industry-academia. In addition to designing the next generation of human resources and higher education, we will link these efforts to the development of the next generation of human resources and higher education.	××[Unachieved].

Contents	Recognition and evaluation
The Government of Japan should promptly develop the Ministerial Ordinance on the Space Resources Act and other necessary systems, guidelines, and standards, etc., so that Japanese private companies can gain a competitive advantage.) through these activities. Through these activities, we hope to develop a network of active lunar business supporters. The goal is to attract foreign companies by raising the country's recognition, and to become a center for the world's most advanced information, while paying attention to the outflow of information to overseas.	△ [Partial progress].
Recommendation 6: As a flagship to arouse public interest in the Moon, the Government of Japan should conduct lunar missions (e.g., sample return of lunar water ice, lunar exploration robots utilizing real-time Earth-Moon two-way communications), taking advantage of the opportunities presented by the Osaka/Kansai Expo. (e.g., tactile transmission experience, etc.) in cooperation with the private sector.	×x [Unachieved].
Recommendation 7: The public and private sectors should share the fact that measures to accelerate the development of these lunar industries will have policy benefits to lead the international community and help solve global issues (e.g., contributing to the SDGs, building a recycling-oriented society, etc.) In addition, from the perspective of economic security, the technology possessed by each company engaged in lunar business Note the strategic indispensability of the technique.	△ Partial progress

1.3 Positioning of the Lunar Industry Vision 2024

Japan is unique in the world in that more than 270 private companies are strongly interested in lunar exploration and utilization and have started some kind of initiatives. Japan should take advantage of the large number of potential players from industry and the wide range of industries from which these players come, and present a unique plan for lunar exploration and utilization both domestically and internationally.

This vision, with Planet6.0 as its core, describes a vision of the future of the Moon from the standpoint of the private sector, and proposes measures that Japanese society and industry should take to realize this vision, while demonstrating their firm presence in the international trend.

Based on the changes in domestic and international circumstances described in Chapter 2, the expansion of the Planet 6.0 concept described in Chapter 3, the results of business studies in each area described in Chapter 4, and the organization and evaluation described in the previous section, we have organized them into two axes: those to be continued and developed from the previous resolutions and recommendations, and those to be newly established as the necessity became clear as a result of the studies. The seven resolutions and seven recommendations are summarized in Chapter 5.

2. Current Status of Lunar Exploration in the World and Japan

Key points of this chapter

- The "Artemis Project," a space exploration program aimed at human exploration, is being steadily implemented mainly by the U.S., and the development of Gateway, which will be constructed through international cooperation, including Japan, is being promoted.
- China's first successful sample return from the far side of the Moon, India'sfourth successful unmanned lunar landing, Japan's fifth successful unmanned lunar landing, and other lunar exploration competitions are gaining momentum
- The private sector as well as the public sector is increasingly taking up the challenge of going to the moon, with Japan'sispace attempting to land on the moon and Intuitive Machines of the United States becoming the world's first private lander to land on the moon.
- The creation of the lunar surface industry and the construction of the cislunar economy are expected to be accelerated through international collaboration.

Since the announcement of the "Lunar Industry Vision - Toward the Planet 6.0 Era" in July 2021, lunar exploration and development have made significant progress. The unmanned lunar orbit test flight "ARTEMIS 1" of the U.S. NASA manned space mission was a success, followed by the manned lunar orbit mission "ARTEMIS 2" and the manned lunar landing mission

In addition to NASA, technological development for lunar exploration is expanding, as evidenced by DARPA's LunA-10 program to promote economic activities on and around the Moon. In addition, the development of the Gateway, which will play the role of a manned lunar orbiting base, is underway through international cooperation with the participation of Japan as well as the United States.

China has made steady progress with the Chang'e mission and successfully conducted the world's first sample return from the far side of the Moon, and is also promoting the ILRS, a lunar base program proposed by China and Russia. In other countries, Russia has announced its intention to participate in the China-led ILRS despite the failure of its probe, and India became the fourth country in the world to successfully land an unmanned probe on the Moon's surface with the success of Chandrayaan-3. Japan's Small Lunar Module Demonstrator "SLIM" also succeeded in the world's first pinpoint soft landing on the Moon, becoming the fifth country in the world to successfully land an unmanned probe on the Moon.

Figure 6: Global Trends and Competition/Cooperation on the Moon
(Source: Prepared by the Lunar Industry Vision Council)

As for private companies, Japan's ispace lunar lander HAKUTO-R M1 became the world's first private company to land on the Moon, although it failed to make a soft landing. Subsequently, Intuitive Machines, a U.S. company that participated in NASA's Commercial Lunar Payload Services (CLPS), became the first private company in the world to successfully land on the Moon. In addition to the Lunar Industry Vision Council and other organizations promoting the lunar industry in Japan, there are also organizations

around the world that are actively working to promote the lunar industry.

2.1 International Trends in Lunar Exploration and Development Applications

2.1.1 U.S. Space Exploration Program

The Artemis program, announced by the United States in May 2019, aims to send humans to the Moon after 2025 and then, through the Gateway (manned lunar orbiting base) program and other programs to be constructed through international cooperation, bring supplies to the Moon, build a lunar base, and sustain human activities on the Moon. It also aims to use the Moon as a foothold for a manned landing on Mars in the 2030s. Although there have been some delays compared to the original plan, the first Artemis mission, "Artemis 1," was conducted in November 2022, and the Orion spacecraft on this mission came as close as 100 km to the Moon's surface and returned to Earth after an unmanned test flight in a lunar orbit. In 2025, four U.S. astronauts are scheduled to board the Orion spacecraft for the ARTEMIS 2 mission, which will fly to the lunar orbit and return to the Earth, and in 2026, the ARTEMIS 3 mission is scheduled to make the first manned lunar landing in half a century since the Apollo missions. In April 2024, the U.S. and Japanese governments agreed that two Japanese astronauts would each land on the Moon in the future as part of the Artemis mission.

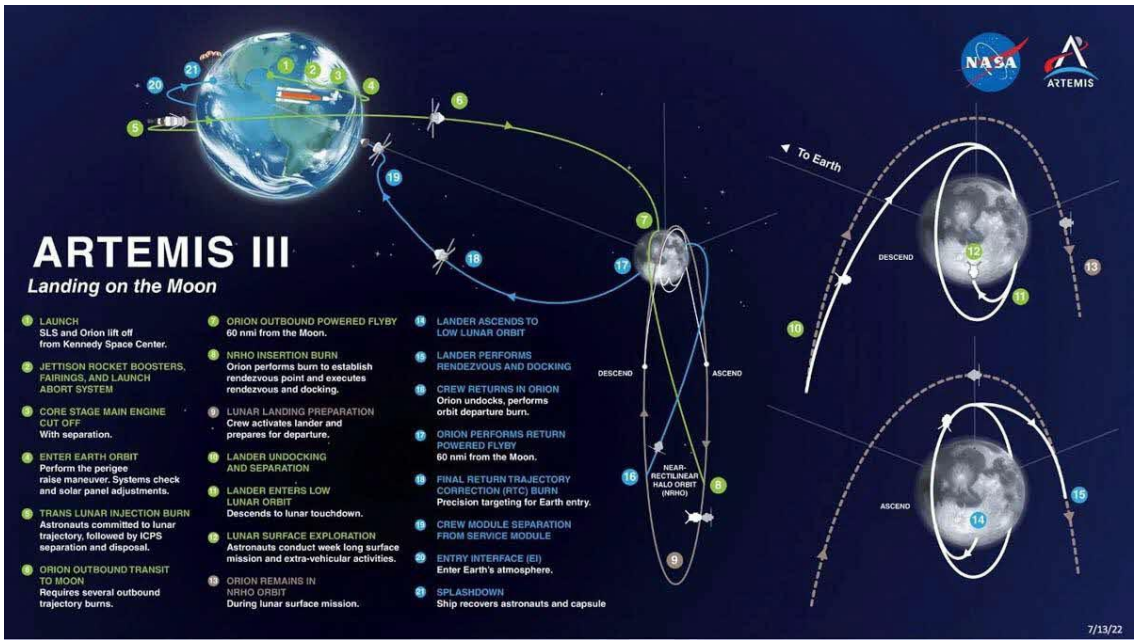


Figure 7: "Artemis 3" Mission Details
(Source: NASA)

The ARTEMIS program is also expected to play an important role in promoting sustainable activities on the Moon, laying the groundwork for the expansion of lunar activities not only by the public but also by the private sector, and serving as a step toward the long-term goal of sending humans to Mars.

Construction of the Gateway, which will be built through international cooperation and will serve as an important manned lunar orbiting base within the ARTEMIS program, is scheduled to begin after 2025. The Gateway will be about 1/6 the size of the ISS, and is expected to be used as a base for future manned exploration of Mars, with four astronauts staying on the Moon for about 30 days a year. Japan will also participate in the Gateway project by providing various equipment, cargo transporters, etc., utilizing the technology it has cultivated on the ISS, and it has been decided that Japanese astronauts will be on board the Gateway in the future.

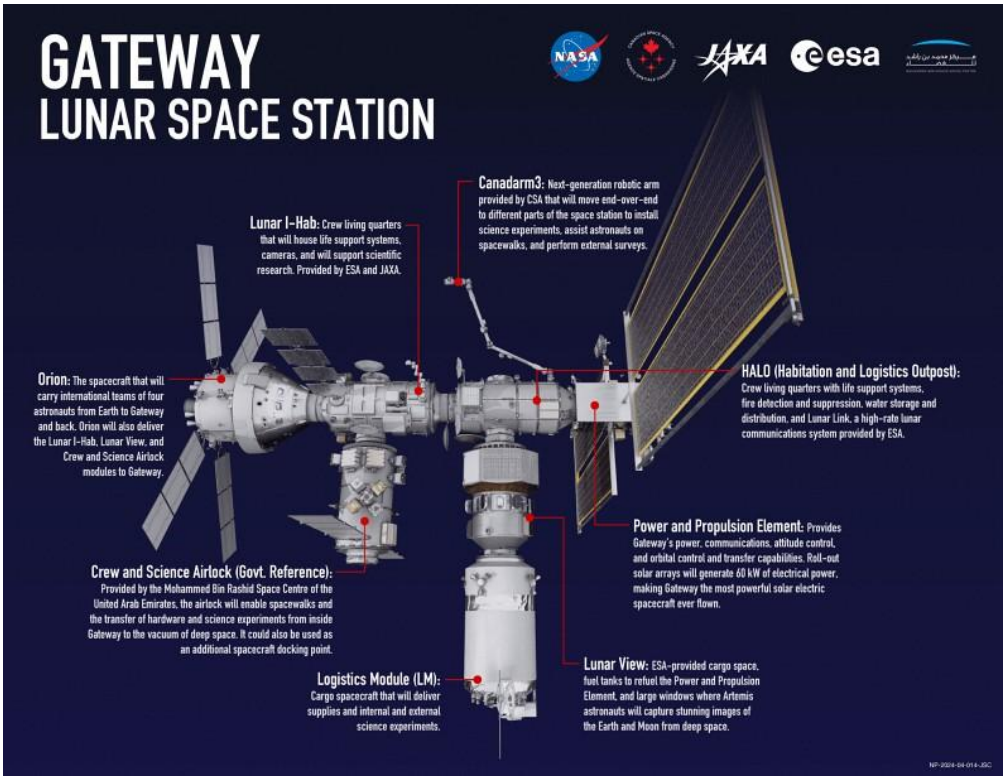


Figure 8: Concept of "Gateway," a manned lunar orbiting base
(Source: NASA)

The United States invited countries to participate in the ARTEMIS program, and in October 2020,at the International Astronautical Congress (IAC), representatives from eight countries (Japan, the United States, Canada, the United Kingdom, Italy, Australia, Luxembourg, and the United Arab Emirates (UAE)) signed the ARTEMIS Agreement, which will promote under common ground rules The Artemis Accord became an international space exploration program to be promoted under a common set of basic rules. Since then, the number of participating countries has continued to expand, with Ukraine, South Korea, Brazil, France, and other countries joining, and currently about 40 countries have signed the agreement. Based on the Outer Space Treaty (entered into force in 1967), an existing international treaty, the Artemis Accord provides for the following necessary elements for space exploration: use for peaceful purposes, transparency, interoperability through international cooperation (to create new standards) support in case of emergency, space object registration, open scientific data, protection of historical sites, and the protection of space The document also outlines the policy for rulemaking on the mining and utilization of space resources under the Outer Space Treaty, prevention of interference with activities (safety zone) reduction of space debris and disposal of spacecraft.

In August 2023, DARPA announced the "10-Year Lunar Architecture (LunA-10)"to promote economic activities on and around the Moon with the aim of realizing a lunar economic zone through an integrated infrastructure framework on the Moon. LunA-10 is a call for architecture studies and the selection of companies to develop the basic technology concepts to move from independent technologies to a set of interoperable systems. Through these studies, DARPA intends to develop an analytical framework to define opportunities for commercial activities on and around the Moon and to identify associated technical challenges, with the final analytical framework to be made publicly available. LunA-10 will be working on (1) construction, (2) Mining, (3) Mobility, (4) Energy, (5) Agriculture, (6) Medical, (7) Robotics, (8) Life Support, (9) Experiments (lunar/planetary science) (10) Communications, (11) Digital infrastructure for modern lunar computing, and (12) PNT as areas that must be developed to maintain long-term development on the Moon. The 14 companies are expected to be selected by December 2023.

selected, and has begun research and development in these areas. In addition, DARPA is planning to launch a commercial lunar

The Lunar Operating Guidelines for Infrastructure Consortium (LOGIC) was established to study and propose interoperability standards for infrastructure, and started discussions and deliberations among stakeholders from industry, academia, and government agencies. LOGIC plans to develop basic technology concepts and standards for lunar technology and activities by utilizing the research results of LunA-10.

2.1.2 Space exploration plans of China, Russia, India, etc.

As described in the previous section, international space exploration has been promoted by the ARTEMIS program led by Japan, the U.S., and Europe, but China, Russia, India, and other countries not participating in the program also have a variety of lunar and Mars exploration achievements and plans.

So far, China has been promoting lunar exploration through the Chang'e program, and since the launch of Chang'e-1 in 2007, it has successfully launched and operated a lunar orbiter and a lunar lander, making the world's first landing on the far side of the Moon in 2019 and a successful lunar sample return in 2020. More recently, the world's first successful sample return from the far side of the Moon was achieved by Chang'e-6, launched in May 2024. In the future, the Chang'e 7 mission aims to land at the South Pole of the Moon, as well as to conduct manned lunar landings and human stays at a lunar base. The planned lunar base is called the International Lunar Research Station (ILRS) and will be constructed in cooperation with Russia. China is aiming for a manned lunar surface stay through the ILRS project, and has invited not only Russia but also other countries to participate in the project. In the case of China's Mars exploration, after the failure of the 2011 launch of the Russian Mars probe Phobos-Grundt, China became the first country to successfully land on Mars by an unmanned vehicle with the launch of Tianmou I in July 2020.

Like the United States, Russia has a long history of lunar and Mars exploration, having launched many unmanned lunar explorers since the 1950s and successfully launched lunar orbiters and landers ahead of the United States. In August 2023, Russia launched its first lunar lander, Luna-25, in about half a century since the 1970s, but it failed because it reached lunar orbit but crashed on the lunar surface before landing. As mentioned above, Russia and China have agreed to proceed with the construction of a lunar base, ILRS, and will continue to work together to build a lunar base in the future,
The plan is to continue the lunar mission, which includes a survey for the construction of the "ILRS."

India has also been developing lunar explorers since the mid-2000s, launching the lunar orbiter Chandrayaan-1 in 2008 and the lunar lander Chandrayaan-2 (which failed to land on the moon) in 2019. In July 2023, its successor, Chandrayaan-3, was launched, and in August of the same year it became the first country in the world to successfully land on the South Pole of the Moon. This made India the fourth country in the world to successfully land an unmanned probe on the Moon, after Russia (former Soviet Union), the United States, and China. India also successfully put a Mars orbiter into Mars orbit in 2014. India's future plans include a joint lunar exploration mission with Japan, based on an agreement between JAXA and ISRO, in which a joint Japan-India lunar polar exploration mission, LUPEX, will be launched by H3 rocket after 2026, with India providing the lander (to land at the lunar South Pole) and Japan providing the launch The lander (to land at the South Pole of the Moon) is being developed by India, and the launch vehicle and lunar exploration rover are being developed by Japan.

On the other hand, South Korea is vigorously pursuing lunar exploration in Asia outside of Japan: in August 2022, South Korea launched its first lunar probe, the Korea Pathfinder Lunar Orbiter (publicly solicited name: Danuri), which was successfully injected into lunar orbit in December 2022. Korea signed the Artemis Accord with NASA in May 2021, and has been sharing deep space communication facilities and scientific data with NASA, as well as planning future lunar exploration missions.

2.2 Movements in Lunar Exploration and Development Utilization in Japan

In Japan, lunar exploration was defined in 2020 as an innovation area in our country's growth strategy, along with 5G,Society5.0, and quantum computing. In response to this, it is time for industry to accelerate the trend toward lunar surface development and utilization as part of its growth business. While the promotion of lunar exploration has been indicated in the Space Basic Plan and other plans, the new Space Basic Plan approved by the Cabinet in June 2023 indicates an approach to promote "sustainable manned activities on the Moon," and the future Japanese landing on the Moon under the Artemis mission, the development of manned pressurized rovers and other technologies necessary for sustainable lunar activities, and the It is further stated that lunar activities will be further promoted through the development of technologies, the formulation of concepts and the establishment of public-private platforms to concretize the lunar surface development process, and the promotion of the formation of norms and rules for the formation of a future market. In addition, the Space Technology Strategy compiled in March 2024 states that in order to sustain manned activities on the Moon, the development and maintenance of power, communication, and positioning systems and food supply systems will be conducted in stages, with the participation of the private sector, through the development and utilization of new technologies such as unmanned construction. The strategy further states that in the future, the Moon's surface will gradually become a living area for humans, and new economic and social activities will be generated, which will lead to the realization of lunar space travel. In addition, through the lunar surface programs implemented by various countries, including the ARTEMIS Project, new industries are expected to be created, including the development of ground-based technologies by private companies for space utilization, and the Moon may develop into a lunar economic zone.

While there are severe financial constraints on state-led lunar development, as in other space fields, it is desirable to establish an economic zone on the Moon with private-sector funds and players, and to develop the Moon in a sustainable manner. Several activities related to lunar development and utilization have already been conducted domestically and internationally, and the number of new private companies has been increasing, which is fostering expectations for the creation of new industries.

2.2.1 Movements in our country related to the Artemis Project

In July 2020, MEXT signed the "Joint Declaration on Cooperation in Lunar Exploration (JEDI)"with NASA, and in October 2020, the Cabinet Office and MEXT signed the "Artemis Accord," an international agreement on lunar exploration by eight countries led by the United States (currently about 40 countries). In October of the same year, the Cabinet Office and MEXT signed the "Artemis Accord," an international agreement on lunar exploration by eight countries led by the United States (currently about 40 countries). In addition, the U.S. has been planning to establish a manned base in lunar orbit through international cooperation.

In December 2020, the "Memorandum of Understanding between the Government of Japan and the National Aeronautics and Space Administration of the United States of America on Cooperation for a Civilian Lunar Orbiting Manned Base" came into effect as an international commitment to implement cooperation regarding the "Gateway. Based on this Memorandum of Understanding, Japan will contribute to the development of the "Gateway" and further promote international cooperation in the space field, while taking advantage of Japan's strengths. In addition, in April 2024, the Japanese and U.S. governments agreed that, as Japan's contribution to the ARTEMIS mission, Japan will be responsible for providing a manned pressurized rover for lunar exploration, and, as mentioned above, two Japanese astronauts will each land on the Moon in the ARTEMIS mission in the future.

In promoting the ARTEMIS mission, particularly in Japan, the U.S., and Europe, it is extremely important to utilize the private sector's vitality. In order for private companies to expand their lunar activities, it is necessary to remove barriers to their activities, and environmental and legal improvements have been made to this end. In response to the increased space activities by the private sector, in November 2018, the

The Law Concerning the Launch and Management of Satellites (commonly known as the Space Activities Act) was enacted to establish a permit system for private-sector launches of rockets and satellites to be managed by the government, as well as guidelines for compensation for accidents involving launches. In

addition, the Space Resources Law was enacted in June 2021, and the Space Resources Law was enacted as a special exception to the Space Activities Law, allowing the ownership of space resources by the Japanese government on a business unit basis. The bill was enacted in June 2021. Thus, as the public and private sectors are pushing forward with the Artemis Project, Japan is taking the lead in international discussions by creating rules ahead of other countries, and there are moves to accelerate entry into the lunar industry business by giving the private sector a competitive edge. As countries around the world plan long-term utilization of lunar resources and development of manned bases that will continue into the 2030s and beyond, it is essential for Japan to continue to actively demonstrate its international presence without stopping at cooperation with the United States or participation in one-time international projects. To this end, conventional state-led space development is not the way to go.

It is important to promote development through an appropriate division of roles between the public and private sectors, to build a sustainable flow of private companies investing in the Moon's surface, and to promote industries that ensure economic rationality.

2.2.2 JAXA's Lunar Exploration Program

Recent developments in Japan's lunar exploration, led by the government, include the Small Lunar Demonstrator "Smart Lander for Investigating the Moon (SLIM)" JAXA launched the lander on the Moon in September 2023, and on January 20, 2024, it successfully made the first soft landing on the Moon in Japan. Japan's first successful soft landing on the Moon on January 20, 2024. Japan became the fifth country in the world to successfully land an unmanned spacecraft on the Moon. At the same time, it was the world's first successful pinpoint landing within 100 meters of the target landing site, which was an important mission objective of the lander.

Japan's future lunar exploration plans include the Lunar Polar Exploration (LUPEX)" will be launched after 2026. The mission aims to land on the lunar polar regions where water is suggested to be possible to exist, and to investigate water resources on the Moon's surface, etc., through a cooperative mission with India. The use of water resources on the Moon is extremely important for manned and economic activities on the Moon, and countries around the world are competing to conduct or plan missions to explore water resources on the Moon for sustainable lunar activities.

JAXA has been continuously studying JAXA's goals, scenarios, and roadmap for the realization of manned lunar exploration as an intermediate goal, with an eye toward the realization of manned Mars exploration, since 2015, and compiled the first "Japan's International Space Exploration Scenario (Draft)" in 2017. The latest version, "Japan's International Space Exploration Scenario (Draft) 2021," was compiled based on changes in the international situation and progress in domestic policy discussions, and presents an overall scenario, overall architecture, and technology roadmap for space exploration, including lunar exploration, at present. The scenario has included a Gateway supply mission by HTV-X, a lunar polar exploration as the first step to utilize lunar water resources, and a pressurized rover, and has played a role in clarifying Japan's position as an international space exploration scenario. The scenarios have played a role in clarifying Japan's position as an international space exploration scenario.

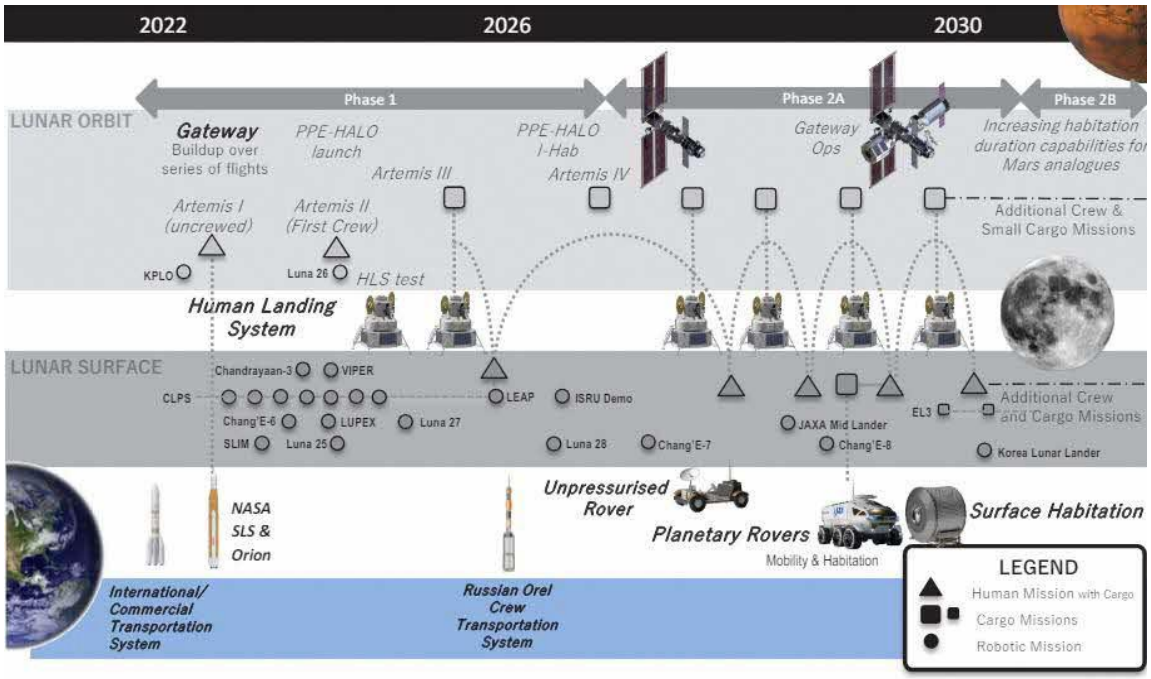


Figure 9: ISECG Lunar Surface Exploration Scenarios
(Source: ISECG)

2.3 Lunar activities by a variety of private companies and the movement to create democratically-led industries

Until the 1990s, lunar exploration was conducted mainly by space agencies of various countries and through international cooperation, but in the 2000s, the private sector began to enter the lunar exploration field. The major catalyst was the Google Lunar XPRIZE (GLXP) the first private sector competition for unmanned lunar exploration, which started in 2007 and was run by the X PRIZE Foundation and sponsored by Google. HAKUTO, led by ispace, participated from Japan. Although no team made it to the Moon's surface by the deadline, it achieved significant results.

Recent private-sector lunar exploration has also been active: in February 2019, Israel's SpaceIL launched the lunar lander Beresheet, and the resulting glitch caused the lander to crash into the lunar surface. In addition, Japan's ispace launched the HAKUTO-R M1 lunar lander in 2022 and became the world's first private company to attempt a lunar landing in April 2023, but the landing failed due to a software glitch. Intuitive Machines, a U.S. private company participating in NASA's Commercial Lunar Payload Services (CLPS) program, then attempted to land on the Moon with the Nova-C lunar module, and on February 22, 2024,it became the world's first private lander on the Moon. On February 22, 2024, Intuitive Machines, a U.S. private company participating in the "CLPS" program, successfully landed on the Moon using the Nova-C lunar module, becoming the first private lander in the world. Many private companies, including ispace, Japan's leading moon-related private company, plan to continue to promote activities related to lunar exploration and the lunar industry, and with the support of the national government and collaboration with the government, lunar activities by private companies are becoming increasingly active.

2.3.1 Lunar activities by the private sector

In recent years, lunar development has not been limited to the government and space-related companies such as ispace, but also includes Takasago Thermal Engineering (Japan), Toyota Motor Corporation (Japan) Euglena (Japan) Takara Tomy (Japan) KDDI (Japan), Caterpillar Inc.

（The project is of a grand scale, involving companies from different industries, such as the U.S. and Finland's Nokia Corporation, and taking a long period of time that spans across generations. This represents the high expectations for the results that can be obtained from lunar surface development, and is a feature that could become a symbol of Planet 6.0.

(i) Transportation sector:

Earth-Moon Transportation

- ispace (Japan)

  ispace sells services for transporting payloads (cargo that can be carried on a lander or rover) to the Moon. The lander-mounted service is for stationary payloads that do not need to be moved, such as cameras, communication equipment, and culture equipment. The HAKUTO-R M1 lunar module was launched in 2022, and in April 2023, it became the world's first private-sector lunar module to land on the Moon, Although the landing failed due to a software glitch, the plan is to continue sending landers to the Moon in the future, and many payloads from private companies, etc. are planned to be carried on the planned landers.

- Fujitsu (Japan)

  Fujitsu has contributed to the successful pinpoint landing of the Small Lunar Module "SLIM" by supporting orbit calculation technology cultivated with JAXA, data transmission, and image navigation. In recent years, Fujitsu has also been contributing to space situational awareness (SSA) in the cislunar region for lunar exploration and safe lunar activities by private companies based on its orbit calculation technology. In addition, Fujitsu and the Tokai National University Organization have begun joint research on the prediction of radiation effects from solar flares with a view to the near future, when the sphere of human activity will expand into space. Fujitsu is actively promoting social implementation of research results, aiming to contribute to safe activities in outer space, including the Moon, Mars, and interplanetary space.

- Mitsubishi Electric (Japan)

One of the SLIM's mission objectives is to "explore the Moon as a place of high scientific value.

The mission was to make a soft landing on the Moon at an altitude of 50 m with a target accuracy of 100 m. In fact, the landing was achieved with an accuracy of 10 m at a lunar altitude of 50 m. Mitsubishi Electric will contribute to high-value-added and sustainable lunar transportation business by utilizing the technological achievements obtained through SLIM.

[Lunar transportation

- Toyota Motor Corporation (Japan)

JAXA and Toyota Motor Corporation are conducting research and development of a manned pressurized rover for launch in the late 2020s. JAXA and Toyota will continue to bring together the technological capabilities and knowledge of companies from various industries to work as "Team Japan" to realize a sustainable lunar surface activity. JAXA and Toyota will continue to take on the challenge of realizing sustainable lunar surface activities as "Team Japan" by combining the technological capabilities and knowledge of companies from various industries. At the Japan-U.S. summit meeting held in April 2024, it was agreed that Japan will provide and operate a pressurized rover for the Artemis mission.

- General Motors (U.S.)

U.S. automotive giant General Motors (GM) announced plans to develop a next-generation lunar rover in 2021 in cooperation with U.S.-based Lockheed Martin Corp. with the aim of adopting it as an exploration rover for NASA'sArtemis program, and plans to develop an automated vehicle that is more maneuverable than conventional rovers and can explore farther. Lunar Outpost is the primecontractor for the development of a manned lunar rover from NASA, with the aim of adopting the rover for future lunar exploration.

(2) Information and Communication

- NEC (Japan)

NEC (NEC) aims to contribute to the field of high-speed communication services and high-precision positioning services, which are indispensable for business development in the lunar and near-moon regions, based on its deep-space communication and high-precision positioning technologies developed through the development/operation of JAXA's lunar orbiter Kaguya and asteroid explorer Hayabusa. Leading efforts include orbit control and guided navigation technologies in Cis-lunar, and next-generation communication technologies.

- KDDI (Japan)

In May 2024, telecommunications giant KDDI announced plans to begin offering communications services on the Moon in 2030, with the aim of commercializing high-capacity communications technology to link the Moon and Earth by light and radio waves in 2028. The plan calls for the establishment of base stations on the Moon's surface and the development of infrastructure to link astronauts and vehicles for exploration with high-speed data communications.

- Warp Space (Japan)

WarpSpace has been conducting research and development of inter-satellite optical communication technology since 2016, and is developing and providing solutions to support the introduction of optical communications by various businesses. In recent years, the number of satellites that conduct earth observation has exploded, and optical communication technology is being put to practical use to enable more earth observation data to be acquired in a near-real-time manner. This will contribute to the realization of a sustainable global economy by speeding up disaster response and improving the efficiency of resource management.

- Nokia (Finland)

Finnish telecommunications giant Nokia plans to test and deploy a 4G/LTE network that could be used on the Moon and Mars. This lunar mobile communications network will be used to control lunar surface vehicles, provide real-time navigation on the lunar surface, and stream high-resolution video.

Media Contents

- Dentsu(Japan)

Dentsu is promoting a marketing rights business using lunar exploration as content. The company invites companies to engage in private-sector lunar exploration, promotes technological and business development, and sells the rights to promote various related activities including such exploration.

- TOPPAN Corporation (Japan)

TOPPAN is engaged in research and development of realistic remote space and environment sharing systems, including "remote communication" using human augmentation technology, AI avatars, robots, etc., and "digital twin" using high-precision 3D measurement technology, high-definition XR technology, etc. The company is also challenging the dual use of terrestrial technologies in space, developing advanced content for the space domain, including the lunar surface, building a new remote platform between the ground and space, and examining the space business from the perspective of DX (Digital Transformation) and SX (Sustainable Transformation). The company is also considering space business from the perspective of DX (Digital Transformation) and SX (Sustainable Transformation).

Resources and Energy

- Takasago Thermal Engineering Corporation (Japan)

Takasago Thermal Engineering, an air-conditioning contractor, will install its water electrolysis equipment in the lander (lunar module) that is to be transported to the Moon by ispace under the HAKUTO-R program. In addition to demonstrating water electrolysis after landing on the Moon, the company aims to generate hydrogen and oxygen in the lunar environment for the first time in the world. In March 2024, the company announced that it had completed development of the lunar water electrolyzer flight model (FM) and delivered it to ispace. The FM will be transported to the Moon's surface by ispace's HAKUTO-R M2, which is scheduled for launch in 2024, for demonstration. The company will apply its air conditioning technology to develop "thermal mining," a technology for extracting water resources that are believed to exist on the Moon's surface, and will also take on the challenge of building a "lunar eco-system" to use water resources as energy on the Moon's surface. The project aims to contribute to society both on the Moon and on the ground.

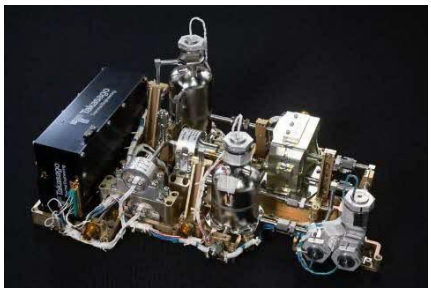


Figure 10: Lunar Water Electrolyzer Appearance
(Source: Takasago Thermal Engineering Co.)

- JGC Global (Japan)

JGC Global, a general engineering company, concluded a "Collaboration and Cooperation Agreement for the Study of a Lunar Propellant Generation Plant Concept" with JAXA and conducted a conceptual study of a lunar propellant generation plant concept using lunar water resources (FY2021 - FY2022). In FY2023, the project was selected as a JAXA project "Conceptual Study of a Pilot Plant for the Realization of a Lunar Propellant Generation Plant," and we studied the overall system of the lunar propellant generation plant, drew up a demonstration plan, and conducted a conceptual study of a demonstration plant for the realization of this project. In addition, from FY2021, the project was selected by the Cabinet Office for the "Strategic Project for Acceleration of Space Utilization".
（The company is also involved in the Ministry of Agriculture, Forestry and Fisheries (MAFF) and Ministry of Economy, Trade and Industry (METI) projects under the "Stardust Program." The company is involved in the design, procurement, and construction of a wide range of social and industrial infrastructure equipment and facilities, including those in the energy sector.

(EPC), and promoting EPC DX as set forth in the long-term information strategy "IT Grand Plan 2030" to contribute to the realization of social and industrial infrastructure on the Moon's surface.

- Niterra (Japan)

The nighttime on the lunar surface and in the shadow of the polar regions are extremely low temperatures of -150 degrees Celsius or lower, and the electrolyte in liquid lithium-ion batteries freezes, so the conventional thermal design cannot be adapted, Therefore, it is thought that the battery will not function as a battery. (Niterra) is conducting research and development of "oxide ceramics" for use in oxide-type all solid-state batteries, which are more environmentally stable than lithium-ion batteries that use an electrolyte or sulfide-type all solid-state batteries that generate toxic gas (hydrogen sulfide).

- Honda R&D Co.

JAXA and Honda Research Institute (Honda) have been conducting a three-year (FY2020-FY2022) joint research project on a manned lunar orbiting base "Gateway" and a circulating renewable energy system on the Moon utilizing Honda's high-pressure water electrolysis and fuel cell technologies. In 2023, Honda and JAXA signed an R&D agreement on a "circulating renewable energy system" to supply electricity for the lunar rover's living space and system maintenance, and are studying the concept of this system and building a prototype in the initial stage.

- Yokogawa Electric Corporation (Japan)

Yokogawa Electric Corporation, whose business domain is measurement, control, and information, is developing a wide variety of sensors and control solutions required on the Moon. In the measurement field, Yokogawa Electric is developing analyzers for water and other resources exploration by applying its Tunable Diode Laser Spectrometer (TDLS) technology, an industrial laser spectrometer with a proven track record on the ground, and is also exploring applications for life support measurements. In the area of control and information, the company is also developing a remote control solution for a lunar propellant production plant.

(5) Construction and infrastructure sector:

- Obayashi Corporation (Japan)

Obayashi Corporation, a construction company, is planning and conducting basic tests of an inflatable structure to be buried underground as a construction method on the Moon, and is also working with OUTSENSE, a space architecture venture company, to develop an origami concept deployment structure and with Saka Seadtech, Muroran Institute of Technology, and JAXA to develop a multipurpose tower deployment structure for power generation and other purposes. The company is also working with Saka Seadtech, Muroran Institute of Technology, and JAXA to develop a multi-purpose tower deployment structure for power generation. These technologies can increase portability by folding the tower into a smaller size for transportation, and may greatly reduce transportation costs, which is one of the most important issues in space manufacturing. On the other hand, we are also working with the Nagoya Institute of Technology and the Laser Technology Research Institute on the creation of locally produced and locally consumed construction materials using lunar sand as a raw material, and are engaged in research and development within the framework of the JAXA Space Exploration Innovation Hub in 2017 and 2021. In addition, the company aims to expand its unmanned construction project, which is being actively developed on the ground, to the Moon's surface. Other initiatives include power generation on the Moon, including solar power, and agriculture using lunar sand as soil.

Figure 11: Image of inflatable structure (left) and model of deployed structure (center) building material using moon-simulated sand (right)
(Source: OUTSENSE, Obayashi Corporation)

- Shimizu Corporation (Japan)

Shimizu Corporation has been engaged in research and development of unmanned construction and utilization of local resources since 1987 toward the realization of lunar surface construction. The company has developed a "lunar soil simulant" that simulates sand on the lunar surface, and is developing excavation technologies for the production of water and construction materials and for civil engineering work. In the framework of the Space Exploration Innovation Hub, the concept of an unmanned construction system was studied in 2016 and the concept of an automatically deployable and retractable over-night shelter was studied in 2018. The company is also working with other companies on the development of technology for a habitat module using a membrane structure.

- TOMY (Japan)

TOMY, a leading toy manufacturer, started research and development of a deformable lunar robot in 2016 under the framework of JAXA's Space Exploration Innovation Hub, and later joined Sony and Doshisha University in a joint research project to develop an ultra-compact and ultra-lightweight self-propelled robot that can operate in the harsh lunar environment. In January 2024,SORA-Q was transported to the Moon's surface by JAXA's lunar lander SLIM, separated from the lander, and then images taken by SLIM were transmitted from SORA-Q to the ground. SORA-Q became the first Japanese robot to land on and photograph the Moon.

- Caterpillar (U.S.)

Caterpillar Inc., a major U.S. construction equipment manufacturer, is developing heavy equipment and vehicles related to lunar surface construction, such as a lunar excavator using automated operation and remote control technology, based on a long-standing partnership with NASA. The company's automated heavy equipment is expected to be used in a wide range of fields, including excavation of resources such as water resources and oxygenated rocks, agriculture, and facility construction, in anticipation of long-term manned missions to the Moon and Mars.

(vi) Food and biotechnology sector:

- Euglena (Japan)

The project aims to achieve local production for local consumption in space by utilizing the living organism euglena (Japanese name: Midori Mushi). In the closed space of human presence in space, the project proposes a circulation system in the closed space that utilizes the photosynthesis and other functions of euglena to process carbon dioxide in exhaled air and nitrogen components in domestic wastewater and convert them into oxygen and nutrients, and aims to realize material circulation on the Moon utilizing advanced breeding of euglena and other microalgae using genome editing and other methods. The project aims to realize material circulation on the Moon by utilizing microalgae such as euglena, which are highly bred using genome editing and other methods.

(vii) Finance/Insurance

- Tokio Marine & Nichido Fire Insurance (Japan)

For the sustainable development of lunar surface exploration, we developed "Moon Insurance" to support lunar exploration missions in April 2022, in collaboration with Beazley, UK. The first project, a lunar exploration mission by Daimon Co.
The company provides this insurance to "Project YAOKI".

- Mitsui Sumitomo Insurance (Japan)

We will participate in the HAKUTO-R project in 2019 as a corporate partner, analyzing the route to the Moon and the possible risks involved in landing, and developing a plan to launch a rocket and a lander in a lunar transfer orbit.
(Lunar Module) is detached from the lunar module, and has held discussions with operators regarding the risks that may arise during the long period of navigation to the Moon and during the lunar landing. Subsequently, in September 2022, as one of the new space insurance lineups, we developed the world's first "Moon Insurance" that seamlessly covers the period from launch to lunar landing, and offered it to operators.

2.3.2 Existence of a community to discuss the lunar industry in which the private sector is proactively involved

Unlike the Earth's orbit, which has been the main stage of space development, the Moon is a celestial body with gravity and ground. In order to establish a manned base there and develop activities such as resource exploration, it is effective to utilize the technologies and assets of not only space-related companies but also various industries from different sectors on the earth, such as automobiles, construction, resources, and energy. With this background, an organization to discuss the lunar industry, in which the private sector is mainly involved, has been established in Japan, and more than 250 companies are currently engaged in some kind of lunar-related activities. Unlike other countries, Japan is unique in that private companies in a variety of industries are working to build a lunar industry. Major communities include the Frontier Business Study Group, the Study Group for Building a Society on the Moon Planet (Moon Village Study Group), SPACE FOODSPHERE, and others, which are engaged in vigorous discussions and deliberations toward the realization of a lunar society.

Also overseas, Euro2Moon, a non-profit organization focused on Europe, and a consortium in the U.S. The Lunar Surface Innovation Consortium (LSIC) has also been established. Euro2Moon was established in 2021 by Japan's ispace in collaboration with Air Liquide and Airbus Defense and Space in Europe to accelerate the cislunar economy, with the aim of creating and leveraging an exchange platform to build a common industrial vision and promote it among the European industrial and institutional ecosystem. It aims to create and leverage an exchange platform to build a common industry vision and promote it among the European industrial and institutional ecosystem. LSIC is a consortium established to support the lunar exploration activities of NASA in the U.S., and aims to promote lunar development technologies through industry-academia-government collaboration. In creating the lunar industry, it is important to collaborate with these organizations and enhance their international presence, which is expected to accelerate the creation of the lunar industry by the private sector and the building of the cislunar economy.

2.3.3 Expanding the use of the private sector in lunar exploration and development

As a variety of private companies are entering lunar exploration, one major trend is the provision of technology, data, and services owned by the private sector to the public sector. In the United States, in particular, the successful purchase of transportation services from the private sector for the ISS has accelerated the trend toward procuring services from the private sector to carry out programs such as lunar exploration. Commercial Lunar Payload Services (CLPS), a program under which NASA will purchase transportation services to the Moon from the private sector, will begin in 2018, with NASA providing a total of US$2.6 billion (approximately 400 billion yen) in funding over 10 years. Under this program, more than 10 missions to the Moon have already been ordered to private companies (some have been cancelled), and the second CLPS mission, the Nova-C lunar lander developed by Intuitive Machines of the U.S., successfully landed on the Moon on February 22, 2024, becoming the world's first spacecraft from a private company. The U.S. has also been working on the "Moon Landing" project. The U.S. also awarded SpaceX a total of US$2.9 billion for the "Manned Landing System on the Moon (HLS)," a manned lander
The trend toward the use of private-sector services is accelerating, as evidenced by the orders to Starship HLS and Blue Origin for the development of a manned lander, Blue Moon, at a total cost of $3.4 billion (approximately 5,200 yen) each, with the aim of launching them in the late 2020s and landing a manned lunar module on the Moon.

Canada is also promoting the Lunar Exploration Accelerator Program (LEAP) to widely utilize industry and academic technologies for lunar exploration activities, and is contributing a budget of 150 million Canadian dollars (approximately 17 billion yen) over five years to support private sector technology development, space demonstrations, and scientific missions. The program has a budget of 150 million Canadian dollars (approximately 17 billion yen) over five years to support private sector technology development, space demonstrations, and scientific missions. Australia is also promoting the "Moon to Mars" initiative, providing 150 million Australian dollars (about 15 billion yen) over five years starting in 2021 to leverage the energies of the private sector and research institutions for technological development for manned lunar exploration and subsequent Mars exploration.

In March 2024, NASA announced that it had selected the Lunar Surface Dielectric Analyzer (LDA), a

device developed by an international research team including the University of Tokyo, as one of the observation instruments that astronauts will take with them when they set foot on the Moon's surface. The device will be developed by an international research team including the University of Tokyo. The instrument, developed by the University of Tokyo and other academic circles together with several companies, is expected to obtain basic scientific data related to the question of whether ice can exist on the Moon's surface.

3. Expand Planet 6.0

Key points of this chapter
- Planet 6.0, a social vision for a social and economic sphere in which Earth and space are integrated
- It is important not only to create new markets on the Moon, but also to view the Moon as an integral part of the Earth and form a recycling-oriented society.
- The scope of Planet6.0 will extend to Mars, and the experience of lunar

3.1 What is Planet 6.0?

In the 50 years since the first footprints were left on the Moon, the domain of human activity has expanded to include outer space, including the International Space Station. In recent years, tens of thousands of satellites have been operated in low Earth orbit, and long-duration stays on the Moon and resource development are underway as realistic plans, mainly by the United States and China. On the other hand, in order to sustain activities on the Moon, the involvement of the private sector is essential, not only in the form of state involvement as in the Apollo era, and as discussed in Chapter 2, private companies are also becoming active both domestically and internationally. Given this situation where human activities, including industry as well as the state, are spreading to the Moon's surface, it is essential to have an awareness of responsibility for the entire environment, including outer space, in order to develop the Moon and space in a sustainable manner. The expansion of activities to the Moon and beyond will create opportunities to look at the Earth from new perspectives (Overview Effect), and interest in space will increase. It is important to recognize that sustainable development from this new perspective will bring various benefits to society, industry, and the lives of people living on Earth.

In the "Lunar Industrial Vision - Toward the Planet 6.0 Era" released in 2021, the Lunar Industrial Vision Council proposed "Planet 6.0" as a concept aiming to build a cyclical social economy that integrates the Earth and space, including other celestial bodies, in view of the fact that the sphere of human social and economic activities already extends into Earth orbit and will expand to the Moon and other celestial bodies beyond the Moon in the near future. In addition to the fact that the human social and economic sphere of activity already extends into Earth's orbit and will expand to the Moon and other celestial bodies beyond the Moon in the near future, we have proposed "Planet 6.0" as a concept that aims to build a recycling-oriented social economy that integrates Earth and space, including other celestial bodies.

Planet 6.0" is a concept that aims to build a recycling-oriented social economy that integrates the Earth and space, including other celestial bodies, in light of the fact that the sphere of human social and economic activity has already extended into Earth orbit and will expand to the Moon and other celestial bodies beyond the Moon in the near future, as the relationship between humans and space has changed over history. The concept aims to build a recycling-oriented social economy in which the Earth and the universe, including other celestial bodies, are integrated.

Figure 12: "Planet 6.0," a social vision for a new era (reproduced below)

(Source: Prepared by the Lunar Industry Vision Council)

3.2 Importance of Planet 6.0

As mentioned above, lunar surface development is expected to be promoted through cooperation between the state and the private sector, and after that, an era will come when the private sector will take the initiative in further promoting lunar surface development and utilization. As space activities increase, the importance of the Planet 6.0 concept is growing, and the Planet 6.0 concept aims not only to create a new market on the Moon, but also to create a recycling-oriented society that returns high value to society and industry on Earth through technological and social innovations fostered on the Moon. The goal is to create a recycling-oriented society that returns high value to society and industry on Earth through technological and social innovations fostered there. The development of robotics, energy technologies, and manned stay technologies will be important to contribute to solving social issues on the earth, and such activities will accelerate the development of automation, energy conservation, healthcare, life sciences, and other areas.

The main industries for lunar activities are space exploration, resource development, and manufacturing.

- Lateral deployment of product technologies developed in the lunar environment
- Mining of lunar resources for consumption on the surface
- Special land use on the moon
- Base for deep space exploration
- Providing sightseeing, exploration, and entertainment
- Creation of new values and methods of international collaboration

3.3 Planet 6.0's Scope Expands to Mars

Mars exploration is significant not only from the perspective of resources and manned activities for future humanity, but also from a scientific perspective, including the discovery of life and its traces, and the advancement of planetary science through understanding the process of environmental change on Mars. The "Moon to Mars Architecture," published by NASA, calls for a stepwise evolution of the study, in the order of landing on the Moon, basic exploration activities, sustained activities, and efforts toward Mars exploration. The document, which is updated annually, positions Mars as the next step after lunar exploration, including the future Mars Sample Return Plan, which aims for a sample return from Mars in 2033.

Japan is expected to conduct research and studies focusing on space science on Mars, develop key technologies useful for future manned exploration, and investigate the Martian environment. Japan has been advancing the Mars Mission (MMX), which aims to observe the Martian atmosphere and return samples from the Martian satellite Phobos in 2031. The Space Strategic Fund is also working on the development of low-cost elemental technologies for atmospheric entry and aerodynamic deceleration for Mars.
（The theme for technological development is "the development of new technologies" (about 10 billion yen).

Thus, the situation is such that Mars exploration and development is taking shape in Japan and abroad as the next step after lunar development and utilization. Planet 6.0 advocates the concept that the Earth and Moon should be viewed as an integral part of a recycling-oriented society and contribute to solving social problems on the Earth. Planet 6.0 is a concept that advocates the formation of a recycling-oriented society by integrating the Earth and Moon, and contributing to the resolution of social issues on the Earth.

Technological developments obtained through lunar exploration could be directly applied to Mars exploration, and the development of new technologies and improvement of existing technologies could revitalize the space industry as a whole and create new business opportunities for related companies. For example, the development of In-Situ Resource Utilization (ISRU) technology on the Moon could be applied to Mars, and the use of local resources could significantly reduce the cost of transporting materials from Earth, and experience in base construction and infrastructure development on the Moon could be useful for base construction on Mars. The experience in base construction and infrastructure development on the Moon will be useful for base construction on Mars, and the know-how in efficient

logistics and base operation will be useful for future missions to Mars.

This can lead directly to cost savings for the company. This will enable more missions to be carried out, which is expected to bring long-term economic benefits. In addition, it is expected that highly skilled human resources will be developed through the lunar and Mars exploration projects. This will increase the number of human resources who can contribute not only to the space industry but also to other high-tech industries, improve the technological capabilities of the economy as a whole, and stimulate R&D investment by educational institutions and companies, which may have an impact on long-term economic growth.

4 Lunar industry business models, issues and policy recommendations

Key Points of this Chapter

- Embodying the Moon Business with the Business Model Canvas (BMC)
- Issues and policy recommendations specific to each business model, issues and policy recommendations common to each business model
- For the independent development of the lunar business, the government needs to support the industry, but the private sector also needs to help themselves, and it is important to establish a mechanism for cooperation between the government and the private sector.

4.1 general remarks

The Lunar Industry Vision Council (LIVC) formed the following nine working groups (WGs) according to the fields of interest of the companies belonging to the LIVC to study issues and policy proposals for the materialization and realization of the lunar business.

(1) Earth and Moon Transportation WG
(2) Building and Infrastructure WG
Information and Communication WG
Resources and Energy WG
(5) Lunar Surface Transportation WG
6) Food WG
Finance and Insurance WG
Media and Entertainment WG
Tourism WG

The relationship between each WG is shown in the figure below. Please refer to the Business Model Canvas (BMC) compiled by each WG for specific details of the lunar business.

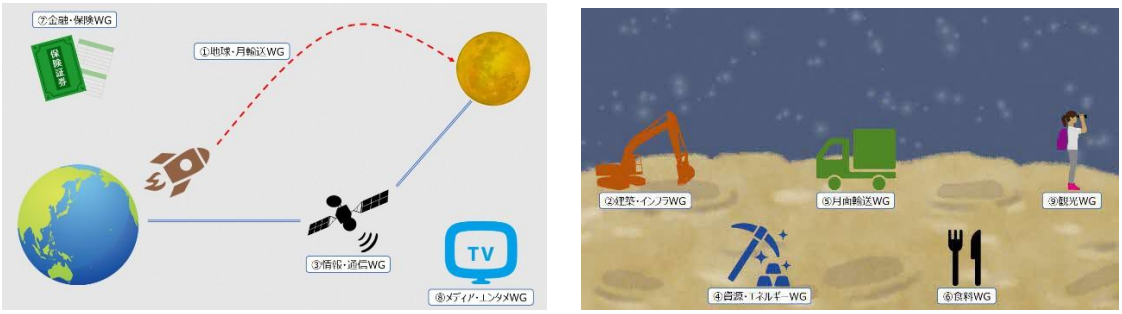


Figure 13: Relationship between each WG

(Source: Prepared by the Lunar Industry Vision Council)

4.2 Prerequisite.

In the 2040s, it is assumed that manned stays, mainly by astronauts, will be established on the Moon. At that time, 100～ 200-person residence bases will be scattered in each of the 5～ 10 areas where water resources exist in the polar regions, making a total stay of about 1,000 people possible. The residence sites provide infrastructure to support activities on the Moon, and are organized by project promotion entities such as countries and regions. Because of the special environment of the lunar surface, most of the visitors are professional astronauts from the public and private sectors, but as the number of visitors expands, the tourism business has begun, mainly for a small number of wealthy people. However, even though the scale of activities on the Moon has been expanding, the infrastructure remains in its infancy, and the supply of life-sustaining resources and food is still largely dependent on transportation from the Earth, although some progress is being made in securing them on the Moon.

While 1,000 personnel are engaged in lunar activities, the main activities are conducted using unmanned robots, and people concentrate on complex operations and areas where decision-making is required. Activities outside the base are conducted by unmanned robots.

By utilizing unmanned technology, mainly bots, the company is able to carry out operations in a variety of fields simultaneously. For example, operations such as infrastructure construction, site management, and base operations are performed by manned teams of several people in each field and base. For external operations such as mining and cargo handling, the company makes extensive use of unmanned robots, thereby reducing the cost of maintaining manned bases and enabling the simultaneous execution of activities in multiple fields.

The scope of activities, including technical constraints, is structured around the stay bases. As a result, the situation is such that independent projects are being carried out at each site rather than in cooperation among sites. Although lunar production and consumption are progressing, most activity capital is based on transportation from the earth. Considering the current transportation cost, the transportation of goods to the lunar surface, which is the source of such activities, is expected to be in the range of 1 to 10 trillion yen, and the proportion of goods transported by private demand is expected to increase to more than half of the total.

By the 2040s, the lunar surface development will be largely in the preparatory phase for R&D and data collection. （The first phase is expected to begin in the 2020s, followed by the transition from demonstration to practical use in the 2030s, and then the transition to full-scale manned stay and provision of services in the 2040s. As the phases progress, it is expected that private companies will take the lead, utilizing the technologies and capabilities they have developed during the previous phases, and that the number of activities will increase significantly.

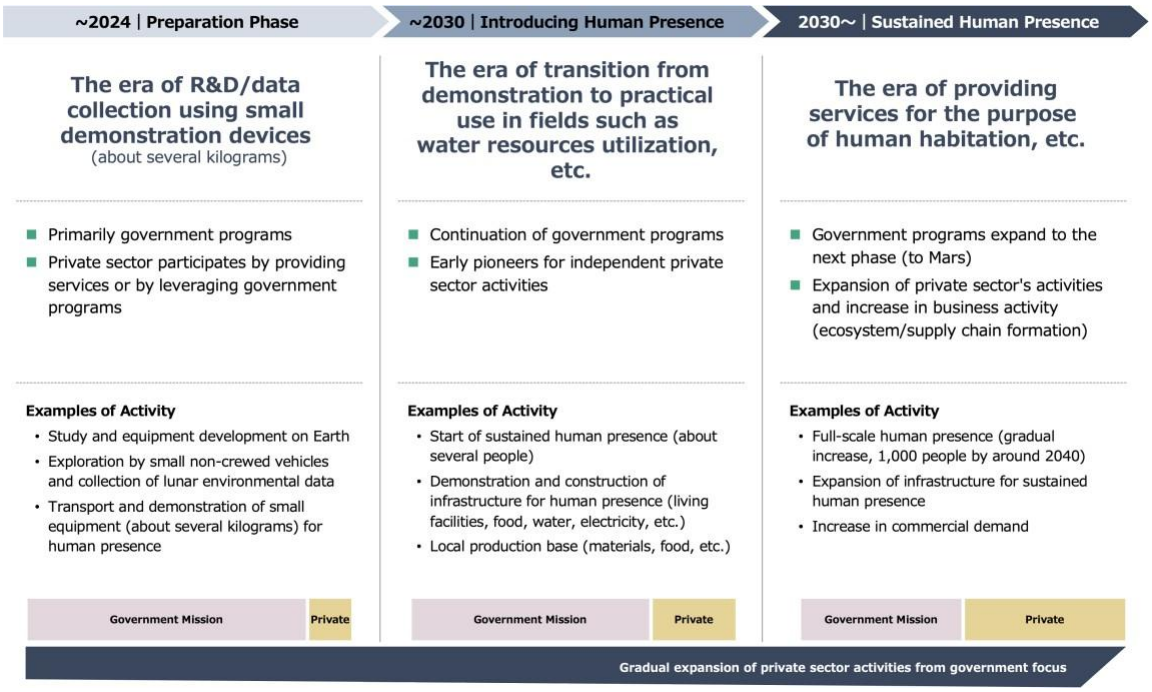


Figure 14: Three Phases of Lunar Development

(Source: Prepared by the Lunar Industry Vision Council)

4.3 Results of discussions in each WG

4.3.1 Earth and Moon Transportation WG

(1) Business Model Overview

The business model considered in this WG is a transportation service to the Moon's surface (or lunar orbit) after launch from the Earth. To develop the Moon's surface, it is necessary to transport materials from the Earth to the Moon. This business model focuses on phase (ii), which can be divided into three phases: (i) launch from the earth by rocket, (ii) separation from the rocket and landing on the moon, and (iii) landing on the moon and reaching the lunar base. However, as discussed below, it should be noted that phases (i), (ii), and (iii) may be considered as an integral part of the business model.

For the time being, it is assumed that the main focus will be on the transportation of goods from the Earth to the Moon's surface (or lunar orbit). Therefore, transportation from the Moon's surface (or lunar orbit) to the Earth is not considered in this business model.

(2) Business Model Details

The business model canvas created by the Earth and Moon Transportation WG is shown below.

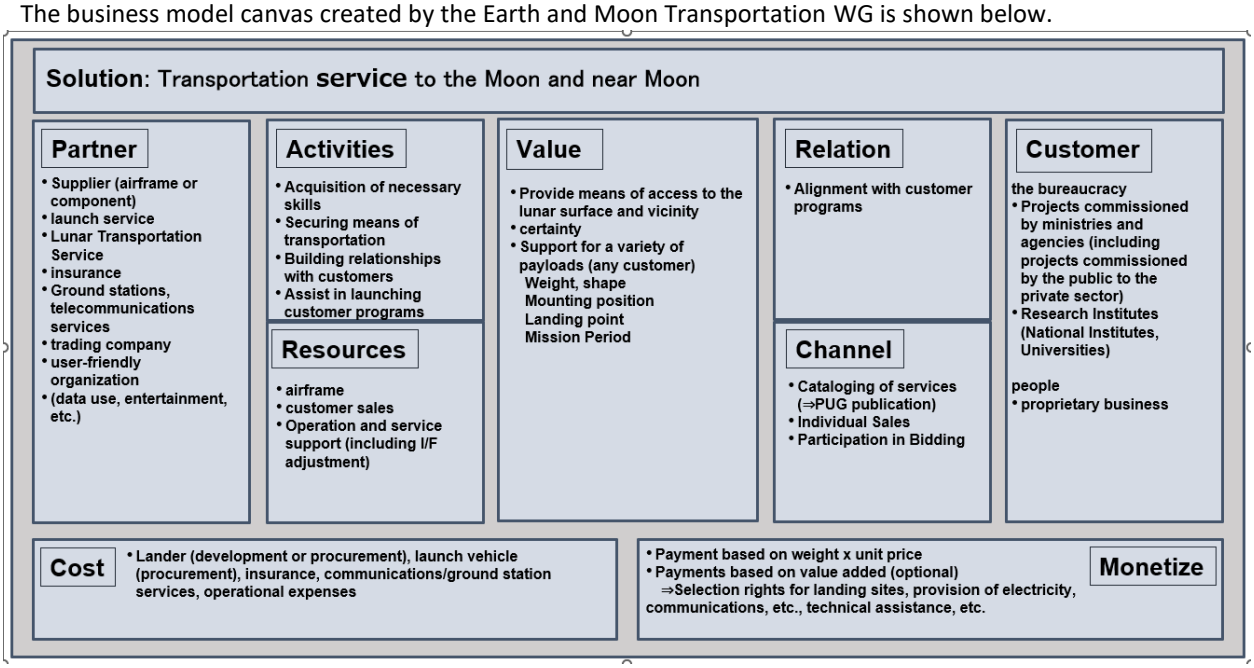


Figure 15: Business Model Canvas (Earth and Moon Transportation WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The objective of this business model is to provide a reliable means of access to the Moon's surface (or lunar orbit). In the future, it will be necessary to allow flexibility in the size, weight, and shape of payloads, and to meet the needs of various customers (and payloads), as well as landing sites and mission durations.

(2) Customers

The expected customers can be broadly divided into public organizations (governments, space agencies, research institutes, etc.) and private businesses. In the initial stage, the former (including projects commissioned by public organizations to private companies) will be the main customers, since lunar surface development is expected to proceed for exploration and technological demonstration purposes first. In the initial stage, the former (including projects commissioned by public organizations to private companies) will be the main focus. However, at the stage when lunar surface development has progressed to some extent, the private sector is expected to move in, and the ratio of private enterprises and base operators that develop the lunar surface is expected to increase.

(iii) Activities required

In order to realize this business model, it is first necessary to acquire the necessary technology to land on the moon, given the high degree of difficulty required to do so.

In addition, it is necessary to uncover potential customers, to make their needs apparent, and eventually to expand the customer base.

(4) Partners needed

When considering the transportation service from the earth to the lunar base as a whole, it is desirable to provide a one-stop service including (i) the phase of launch by rocket from the earth, (ii) the phase of separation from the rocket to the lunar landing, and (iii) the phase of landing on the moon and then to the lunar base. Therefore, a launch service provider and a lunar surface transportation service provider are needed as partners.

In addition, suppliers capable of manufacturing the airframe or its parts to be used for Earth and Moon transportation will be required, as well as communication service providers to exchange communications with the airframe.

In addition, in order to expand the number of end-users and thus the base of the lunar business, it will be necessary to collaborate with organizations that can promote the utilization of data acquired on the Moon (or in lunar orbit).

(3) Issues and Policy Recommendations

	issue	policy advocacy
(i) Technical aspects	✓ Accumulation of technologies related to Earth and Moon transportation	✓ The technical capabilities possessed by the private sector Launching R&D programs to take advantage of
(2) Business aspects	✓ Limited number of immediate customers.	✓ Business conversion support for potential customers ✓ ni through the promotion of data utilization. Digging up the needs of the people of the world
(iii) Legal policy aspects	✓ Lunar landing site coordination rules not yet in place ✓ Scope of responsibility of operators, customers, and the State is unclear	✓ Development of international and domestic rules ✓ Clarification of the scope of responsibility of each party

(1) Technical aspects

The most important technical challenge is the need to accumulate technologies related to Earth and Moon transportation.

To this end, it is necessary to launch an R&D program to utilize the technological capabilities of the private sector in the development of advanced technologies for more accurate and sustainable Earth and Moon transportation.

(2) Business aspects

In terms of business, the current situation is that only a limited number of customers, such as governments, space agencies, and research institutes, can be expected to participate in the lunar surface business. Therefore, in order to expand the customer base, a system to support business development should be established for potential customers who are considering participating in the lunar surface business. In addition, since it is not clear how to utilize the data acquired on the Moon (or in lunar orbit),

and hence needs have not been identified, an organization that can promote the utilization of the above data should be established to identify the needs.

In addition, in order for earth and lunar transportation services to be provided at high frequency and at reasonable prices, the supply chain should be reviewed to make it suitable for mass production, and subsidies to suppliers with relevant technologies should be promoted.

In addition, it is essential for this business model to secure low-cost and reliable launch services by core launch vehicles. In addition, it is essential for this business model to secure low-cost and reliable launch services by core launch vehicles, etc. In order to strengthen the capability and competitiveness of core launch vehicles, etc., it is important for a country to have low-cost and reliable launch means.

measures should be implemented.

(iii) Legal policy aspects

One of the challenges in terms of legal policy is that there are no rules for coordination with other countries or private operators of other countries, even though the landing sites on the Moon may be close to each other. Therefore, it is necessary to establish international and domestic rules to prevent conflicts with other countries or private operators in other countries.

In addition, the scope of responsibility of operators, customers, and the government for Earth and Moon transportation services is unclear, so it is necessary to clarify the rules regarding this issue.

Japan, which has an advantage in lunar surface development, should lead the discussion on all of the above.

4.3.2 Building & Infrastructure WG

(1) Business Model Overview

The business model studied in this WG is to construct a base on the Moon. In order to start a business on the Moon, it is necessary to develop infrastructure such as a base, which is assumed to be constructed by a construction company or in cooperation with a construction company, rather than by a lunar surface exploration company itself.

This business model is based on a combination of the construction phase (hereinafter referred to as "construction phase") and the operation phase (hereinafter referred to as "operation phase") of the base. This business model can be divided into two major phases: the construction phase (hereinafter referred to as the "construction phase") and the operation phase (hereinafter referred to as the "operation phase"). This business model can be divided into two major phases: the construction phase (hereinafter referred to as "construction phase") and the operation phase (hereinafter referred to as "operation phase").

Although this business model itself is designed for base construction on the Moon, the technology can be applied to extreme environments and disasters on Earth as well, and is expected to contribute to environmental improvements on Earth.

(2) Business Model Details

The business model canvas created by the Building and Infrastructure WG is shown below.

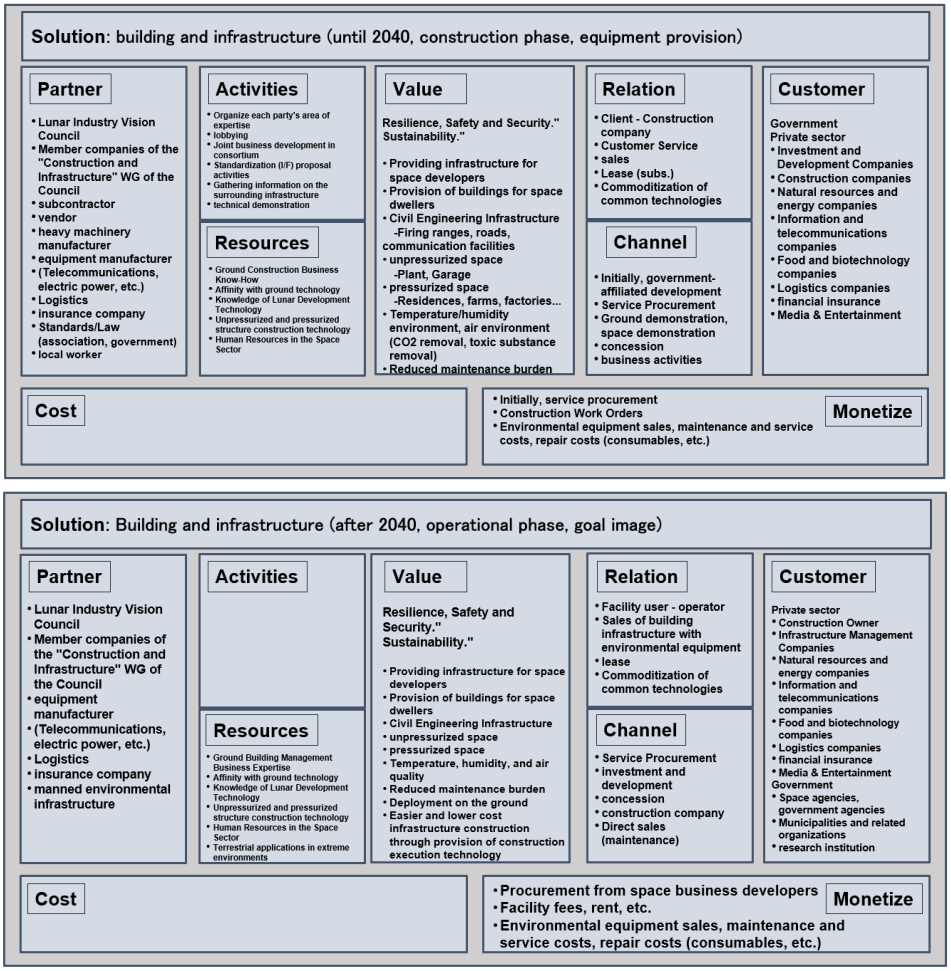


Figure 16: Business Model Canvas (Building and Infrastructure WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The objects of this business model are assumed to be (i) civil engineering infrastructure such as launch pads, roads, and communication facilities, (ii) unpressurized spaces such as plants and garages, and (iii) pressurized spaces such as living spaces, farms, and factories. First, rockets need to be able to take off and land, followed by unmanned facilities, and then manned facilities.

(2) Customers

In the construction phase, public organizations such as governments, space agencies, and research institutes are expected to be the main customers. This is also true on the ground, since it is difficult to assume that private companies will be the main customers from the beginning, since infrastructure construction requires a large amount of money compared to other projects.

However, private companies are expected to be the customers in the later stage of the construction phase or the operation phase. In particular, since the operation phase does not require as much cost as the construction phase, some companies that develop resources on the Moon are expected to operate the Moon, some companies that constructed the Moon may operate the Moon as it is, and some companies that specialize in management and operation may take over the operation of the Moon.

(iii) Activities required

Since each construction company has its own strengths and weaknesses, it will be necessary to create a system in which each company can work in its own specialty, after identifying the strengths and weaknesses of each company. In this connection, it is also necessary to form a consortium to conduct joint research and development, rather than having a single company work on its own.

In addition, as described below, rules for the use of the lunar surface and construction on the lunar surface have not yet been established, so it is necessary to work on the formation of such rules.

(4) Partners needed

In the construction phase, of course, no single construction company can complete the project alone. (In addition, since the special characteristics of space are significant, specialists who are familiar with these special characteristics are needed. In addition, specialists who are familiar with the special characteristics of space are also needed.

In the operation phase, more equipment providers such as telecommunication and electric power companies will be needed, as well as companies that can develop and operate infrastructure for a manned environment.

In both the construction and operation phases, insurance for goods and people is likely to be required, so cooperation with insurance companies will be necessary, and the cooperation of lawyers will also be needed to establish rules.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Absence of opportunities to demonstrate the lunar environment	✓ Government procurement of unmanned construction technology services to ensure demonstration opportunities
(2) Business aspects	✓ High transportation costs	✓ Possession of Japan's own means of transportation, Joint operation of facilities with other countries
(iii) Legal policy aspects	✓ Lunar land use rules not yet in place ✓ Technical Basis for Lunar Architecture absence of a quasi-	✓ Establishment of international rules ✓ Development of technical standards and guidelines for lunar surface buildings

(1) Technical aspects

One of the technological challenges is that technological development will not progress without

opportunities to demonstrate the lunar environment. Therefore, the government should procure unmanned construction technology services, etc., so that the private sector can contribute to the development of the technology.

In addition, Japan should not depend on operators in other countries for transportation to the Moon, but should own the means of transportation to the Moon. In addition, Japan could prevent delays or reductions in demonstration opportunities by providing its own means of transportation to the Moon, rather than relying on operators in other countries.

(2) Business aspects

One of the business challenges is the unavoidable cost of transportation. Therefore, Japan could reduce transportation costs by possessing its own means of transportation to the Moon. Japan could also reduce costs by cooperating with other countries and jointly operating communication facilities.

In addition, since there is not enough open discussion among government, industry, academia, and government, a forum for communication should be established, such as by forming a consortium among government, industry, academia, and government.

(iii) Legal policy aspects

One of the issues in terms of legal policy is that international rules for the use of lunar land have not yet been established. Therefore, in order to avoid disputes with other countries and operators, it is necessary to formulate rules regarding the scope and period of time during which construction of bases, etc. is allowed and the expropriation of bases after completion of operations.

In addition, in relation to the above rule formation, there are no established rules on what level of standards should be met for buildings on the lunar surface, which lacks predictability for operators. Especially when manned facilities are assumed, it is necessary to establish certain technical standards and guidelines to ensure the safety of such facilities.

4.3.3 Information and Communication WG

(1) Business Model Overview

The business model studied by this WG group is to establish an Earth-Moon backbone communication service. Although low-speed communication using radio waves is still possible between the Moon and Earth, this business model will establish a gigabit-level high-speed and stable large-capacity communication service between the Moon and Earth, which is indispensable for promoting lunar development.

The Earth-Monthly Core Communications Service consists of five parts: (i) Earth Infrastructure Service, (ii) Earth Orbiting Satellite Service, (iii) Earth-Monthly Communications Service, (iv) Moon Orbiting Communications Service, and (v) Moon Infrastructure Service. Optical communication technology (especially ultra-long distance optical communication) is essential to achieve high-speed communication, but near-Earth and near-Moon (especially near-Earth where optical communication is blocked by clouds) is expected to be a hybrid with radio wave communication.

(2) Business Model Details

The business model canvas created by the Information and Communication WG is shown below.

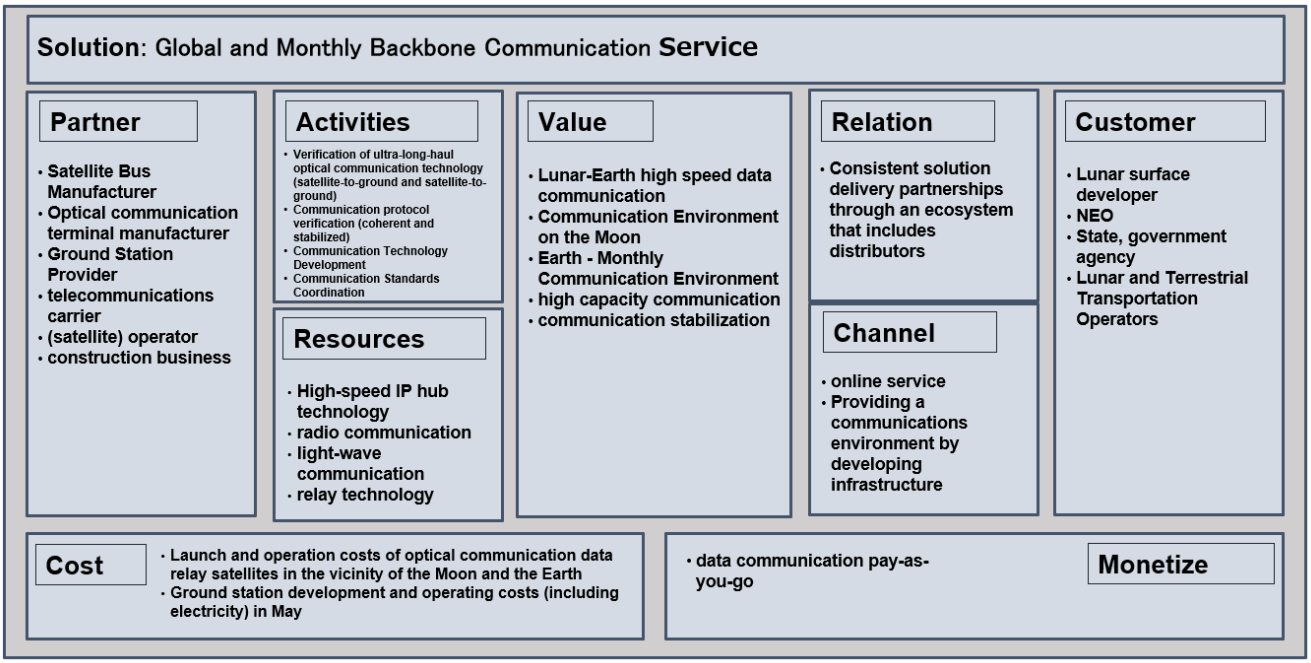


Figure 17: Business Model Canvas (Information and Communications WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The goal of this business model is to establish Japan's own communication network and technology, to be able to make recommendations on international standards, and to build an organization for this purpose. Ideally, Japan should be able to establish its own Lunar-Earth Core Communications Service that does not depend on the manned lunar orbiting base Gateway in order to ensure Japan's independence in communications and eliminate international country risks. On the other hand, considering the enormous construction cost, it is desirable to form a redundant network through international cooperation, and from an economic standpoint, Japan should aim for open communications, including a communications network between the Moon and Earth. Japan should position itself as a leading stakeholder in the Moon-Earth project by having its own communications network with minimal cost and contributing to this open network, and maintaining its voice in international standards.

(2) Securing customers and funds

In addition to national governments and government agencies, possible customers for this business model include lunar surface developers, near-Earth satellite operators, and lunar-terrestrial transportation

operators.

In principle, government support is essential for securing funds to generate telecommunication revenues, although some equity investment by private operators is possible.

(iii) Activities required

First and foremost, it is necessary to establish ultra-long-haul high-speed optical communication technology.

In addition, in order to build an efficient communication network, it is necessary to unify communication standards that are currently in disarray, or to establish technologies that enable communication between different standards.

In addition, stable satellite operation in lunar orbit and frequency coordination on the lunar surface to secure finite and scarce radio waves will be internationally required.

(4) Partners needed

Along the above five parts, ground station providers, near-Earth satellite constellation service providers, operators of optical communication data relay satellites in the lunar and near-Earth regions, satellite bus manufacturers and optical communication terminal manufacturers that manufacture these satellites, construction companies that build lunar infrastructures equivalent to Earth ground stations on the Moon, and telecommunication providers are required. Construction companies and telecommunication companies that construct lunar infrastructures equivalent to Earth's ground stations on the Moon are also required. Existing Earth infrastructure (ground stations) can be used.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Construction and operation of ultra-long distance communication systems ✓ Establishment of hybrid optical and wireless communications in the vicinity of the Earth and Moon	✓ Launch of R&D program to develop highly efficient high data rate communication technology for ultra long distance communication ✓ Launch of Constellation Demonstration Program in Earth and Lunar Orbits
(2) Business aspects	✓ By existing satellite constellation service providers Exclusive Earth-orbiting satellite service	✓ Group/troup to study earth and lunar orbital business starting up a body
(iii) Legal and policy aspects	✓ The mechanism of lunar frequency tuning... absence of a rule	✓ Internationally negotiable organization (public) (a target institution).

(1) Technical aspects

First, please note that the Space Technology Strategy (decided by the Space Policy Commission on March 28, 2024) includes many technical issues and recommendations that are also common to this business model.

While these remain important, other technical issues include the construction and operation of ultra-long-range communication systems (inter-satellite/satellite-to-ground communications, data relay and in-orbit data storage, in-orbit satellite-to-satellite acquisition, circuit design for long-distance transmission, coding, and other communication schemes). The first step is to develop and implement a super long-haul data transmission system. To this end, an R&D program should first be launched to develop highly efficient high data rate communication technologies for ultra-long distance communications.

In addition, as mentioned above, it is assumed that near-Earth and near-Moon communications will be a hybrid of optical and wireless communications, so it is necessary to launch a constellation demonstration program in Earth orbit and lunar orbit using a hybrid system of optical and wireless communications.

(2) Business aspects

However, satellite constellation service providers such as the U.S. have a monopoly on Earth-orbiting

satellite services, which is a problem from a business perspective. However, the U.S. and other satellite constellation service providers have a monopoly on Earth-orbiting satellite services. Therefore, a group/organization should be established to study the Earth orbit and lunar orbit business, which is comparable to the satellite constellation service providers including the U.S., for the orbit services that constitute the backbone of the telecommunication infrastructure.

(iii) Legal policy aspects

One of the legal and policy issues is the lack of a mechanism or rules for frequency coordination on the lunar surface. The International Telecommunication Union (ITU) is in charge of frequency coordination in the vicinity of the Earth, and the Ministry of Internal Affairs and Communications (MIC) is in charge of international negotiations there. Even if it is established, it is not clear which agency or organization in Japan will be in charge of international negotiations. Therefore, a Japanese organization (public organization) should be established to develop and secure the frequency rights for lunar-Earth communications infrastructure and lunar surface activities, which can negotiate within an international framework.

As a prerequisite for this, a function to collect information on the needs of various businesses related to lunar surface development, such as what kind of frequency bands they would like to use, is required. This group could be linked to the group/organization mentioned in the policy recommendation on business aspects (2) above.

4.3.4 Resources & Energy WG

(1) Business Model Overview

The business model considered in this WG is a service to collect, generate, and supply resources and energy such as hydrogen, oxygen, water, and electricity on the Moon. In terms of resources, water and metallic minerals are considered, which are assumed to be used for lunar surface life and lunar surface industries (food production, construction, etc.). In terms of energy, hydrogen, oxygen, and electricity are considered, and these are assumed to be used for lunar surface life and lunar surface industries (food production, construction, etc.).

（The lunar module is expected to be used for lunar transportation (food production, construction, etc.), and also as a power source for lunar and terrestrial transportation.

(2) Business Model Details

The business model canvas created by the Resources & Energy WG is shown below.

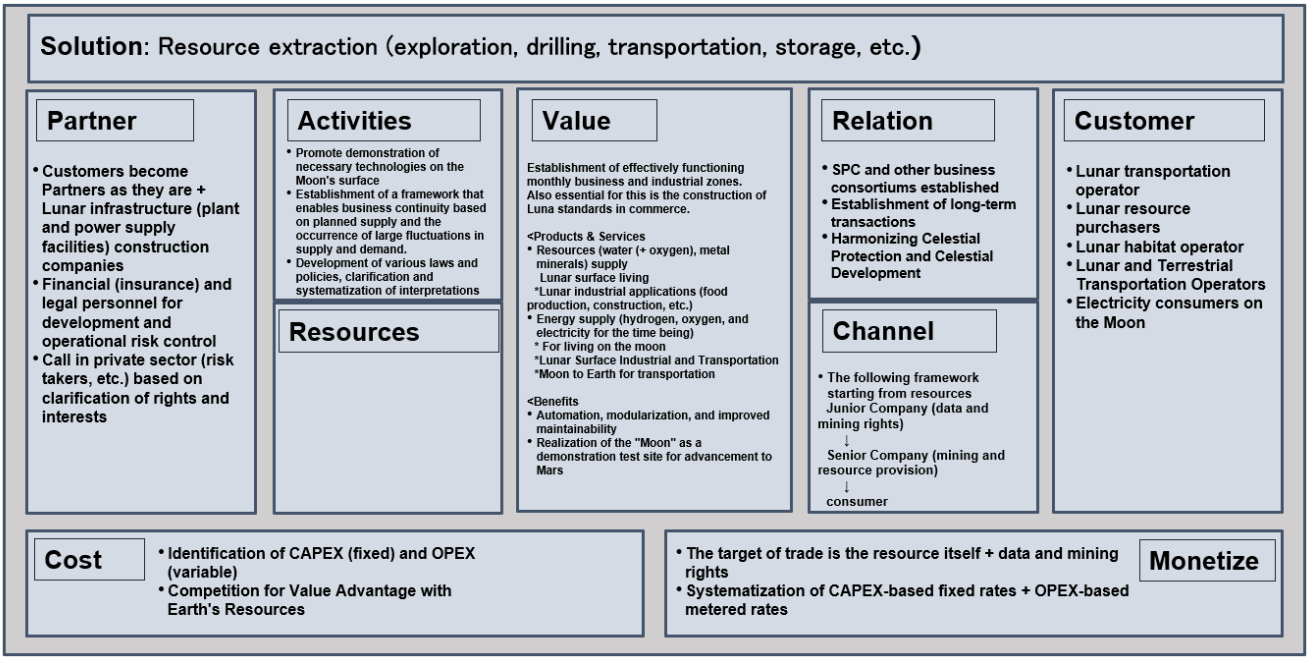


Figure 18: Business Model Canvas (Resources & Energy WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The purpose of this business model is to provide a stable supply of resources and energy on the Moon. First, electricity is necessary for all activities on the Moon. When manned activities are conducted and travelers appear on the Moon, it will be essential to provide a sustainable and stable supply of resources and energy, such as oxygen and water, in addition to electricity. Furthermore, if hydrogen and oxygen produced by electrolysis of water that can be procured on the Moon can be used as propellant, it is more economically rational than transporting propellant from the Earth to the Moon or from the Moon to the Earth.

(2) Customers

Possible customers include lunar habitat operators, lunar surface transporters, and lunar/terrestrial transporters. In the initial stage, lunar surface development is expected to proceed for exploration purposes, and public organizations (government, space agencies, research institutes, etc.) are expected to be the main customers. At the stage when lunar surface development has advanced to a certain degree, private companies will enter the market and the number of travelers will increase, which will lead to the development of private companies that develop the lunar surface.

（The proportion of the lunar surface (resource developers, power suppliers, transportation companies, etc.) and the operators of lunar habitats where travelers stay is expected to increase.

(iii) Activities required

In order to realize this business model, it is first necessary to acquire the necessary technology. In addition, as described below, the rules for supplying resources and energy on the lunar surface have not been finalized.

Since there is no such thing, it is necessary to work on the formation of such rules.

(4) Partners needed

Cooperation with customers is essential in this business model. It is also possible that the customer may become a partner, such as a resource developer and a resource supplier working together.

In addition, cooperation with lunar surface constructors will be required, as plant and power supply facilities will be needed for the project, and cooperation with insurance companies will be needed to control development and operation risks. In addition, cooperation with legal experts will be necessary to establish rules.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Acquisition of technology related to resource extraction ✓ Acquisition of technologies for power generation, transmission, etc.	✓ Secure opportunities for demonstration on the lunar surface, and develop and promote the relevant technologies. Clarification of needles
(2) Business aspects	✓ Difficulty in predicting supply and demand balance ✓ finiteness of resources	✓ Underwriting of certain demands by public institutions ✓ Sustainability Global Building a new framework
(iii) Legal policy aspects	✓ National and international laws on the use of land and resources on the Moon unmaintained	✓ Japan-led rule making

(1) Technical aspects

In terms of technology, the country needs to acquire water resource exploration and site survey technology, mining, production, and refining technology, and transportation and supply technology. For electric power, it is necessary to acquire technologies for power generation, transmission, storage, and storage.

Since neither of these technologies is at a sufficient level of technological maturity, it is necessary to secure opportunities to demonstrate these technologies on the Moon.

The government needs to clarify its policy for fostering and promoting these technologies, because acquiring these technologies will enhance Japan's advantage in resource mining on the Moon and in securing utilization rights related to resources.

(2) Business aspects

One business challenge is that it is difficult to predict the supply-demand balance. It is necessary for public organizations, which will be the main initial customers, to underwrite a certain level of demand and promote the commercialization of the project. Another issue is that extractable resources on the Moon are finite, so there is a risk of depletion and profitability deterioration. Therefore, it is necessary to establish a global framework (Lunar Standard) for sustainable production and utilization plans in cooperation with governments.

It is also worth mentioning that until the construction and operation of production facilities on the Moon reach a steady state, it will be less expensive to transport resources from the Earth. In this regard, while promoting technological development and fostering, it is necessary to give additional value to the Moon by clearly positioning it as a demonstration site for advancing to Mars.

(iii) Legal policy aspects

One of the legal and policy issues is that domestic and international laws regarding the use of land and

resources on the Moon have not yet been established. We hope that Japan will take the lead in rule making so that Japan can gain an advantageous position. Clarifying the rules will clarify the preservation of rights and profits for private operators and increase the predictability of risks, which in turn will encourage private operators to enter the market. In implementing this business model, it is desirable to have an international organization or the national government grant certain permits and approvals, rather than private operators doing so on their own.

I am sorry.

In addition to promoting development, it is also necessary to keep in mind environmental protection, and for this purpose, it is necessary to establish rules for lunar surface development that also take environmental protection into consideration.

4.3.5 Lunar Transportation WG

(1) Business Model Overview

The business model considered by the WG is a lunar surface transportation service. In order to construct and operate a base on the Moon, it is necessary to transport goods and people from the Earth to the Moon. In this case, the phase from the launch on the earth to the landing on the moon and the phase from the landing on the moon to the lunar base can be considered separately, and this model focuses on the latter phase. However, as discussed below, it should be noted that the former phase and the latter phase may be considered as an integral part.

This business model will be implemented in two phases on the lunar surface. This business model can be divided into two major phases: the phase in which human presence on the Moon begins (hereinafter referred to as "human presence phase") and the phase in which human presence on the Moon is fully developed (hereinafter referred to as "human presence phase"). The business model can be divided into two major phases: the phase in which human presence on the Moon begins (hereafter referred to as the "human presence start phase") and the phase in which human presence on the Moon is in full swing (hereafter referred to as the "human presence full-scale phase").

(2) Business Model Details

The business model canvas created by the Lunar Transportation WG is shown below.

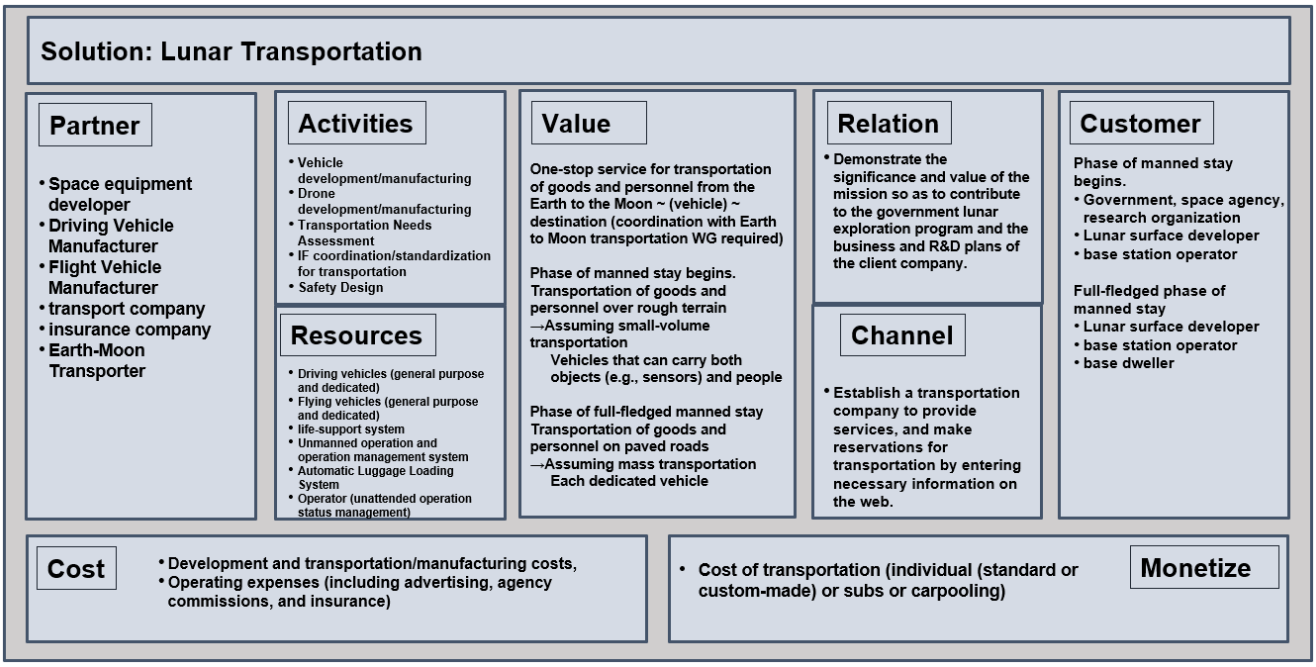


Figure 19: Business Model Canvas (Lunar Transportation WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

First, during the manned stay phase, the Moon's surface is still under development and has not yet been cleared, and the amount and number of cargoes to be transported are expected to be small. Therefore, the vehicle to be used for transportation is expected to be a so-called off-road vehicle.

On the other hand, during the full-scale manned stay phase, the lunar surface will have been cleared to some extent, the frequency of global and monthly transportation will increase, and the amount and number of people to be transported will also increase. Therefore, it is expected that specialized vehicles for mass transportation will appear, depending on the location of transportation and the objects to be transported.

(2) Customers

In the phase to start human presence on the Moon, it is assumed that public organizations such as governments, space agencies, and research institutes will be the main targets, since it is expected that

lunar exploration will be the first step in the development of the Moon.

However, as the manned stay phase progresses into the full-scale phase, the private sector is expected to enter the market to some extent, and the private sector is likely to shift its operations to the private sector, with clients expected to include companies engaged in lunar surface development and base operations.

(iii) Activities required

In order to realize this business model, a vehicle used for lunar transportation must first be developed and manufactured. If only supplies are to be transported first, unmanned vehicles will need to be developed and manufactured. If human transportation is also required, it will be necessary to develop and manufacture an unpressurized vehicle that requires the use of a space suit, or a pressurized vehicle that does not require the use of a space suit.

(4) Partners needed

When considering the transportation service from the earth to the lunar base as a whole, it is desirable to be able to provide a one-stop service together with the phases from the launch on the earth to the lunar landing.

In addition to manufacturers of vehicle bodies, manufacturers of space equipment such as communication and navigation devices are also needed to develop and manufacture vehicles for lunar transportation.

In addition, insurance for the goods and people to be transported will be required, so cooperation with insurance companies will be necessary.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Development of a lunar transportation vehicle ✓ Development of life support systems ✓ Development of unmanned operation management system	✓ Secure opportunities for demonstration by private operators
(2) Business aspects	✓ Limited immediate clientele. after an inflectable word, creates a noun phrase indicating something the speaker does not feel close to	✓ By continuous procurement by the government. Business start-up support
(iii) Legal policy aspects	✓ Rules regarding ownership, occupancy, and use rights when land is cleared on the Moon have not yet been developed ✓ Transportation of goods and people on the Moon's surface absence of a rule	✓ Japan-led rule making

(1) Technical aspects

As technical issues, (i) development of a vehicle that can withstand the lunar environment, (ii) development of a life support system for the lunar surface, and (iii) development of an unmanned operation management system suitable for the lunar environment have not yet been completed. In particular, for (iii), it is insufficient to simply convert the unmanned operation management system on the Moon to the one on Earth, because there are almost no landmarks on the Moon, unlike on Earth. Therefore, it is considered that the government should secure opportunities for demonstration by private companies.

(2) Business aspects

One business challenge is that, at present, only government and research institutions are expected to be customers. However, in the future, as lunar surface activities become more active, not only demand from the government and research institutes will increase, but also from the private sector. Therefore, in preparation for such a stage, it is necessary for the government to act as an anchor tenant by continuously purchasing procurement and supporting the start-up of business.

(iii) Legal policy aspects

The first issue in terms of legal policy is that there are no clear rules regarding the ownership, occupancy, and use of the lunar surface when it is cleared.

Another point is the lack of rules for transporting goods and people. In particular, appropriate transportation rules are needed for the transportation of goods, since nuclear power is expected to be utilized on the Moon's surface. In addition, safety standards for vehicles should be considered for human transportation.

In addition, it is necessary to consider operational rules, such as the need for two vehicles to run at the same time in case of an emergency.

While coordination among nations will be necessary for all of the above, Japan, which has a certain advantage in lunar surface development, should actively lead the discussion.

4.3.6 Food WG

(1) Business Model Overview

The business model studied in this WG is to provide an advanced resource recycling type food supply system for the purpose of stable food supply necessary for sustainable activities on the Moon, reduction of material transportation volume, and securing the quality of life (QOL) in an extreme environment. This system consists of (i) a food production system, (ii) a resource recycling system, and (iii) a QOL management system.

(i) The "Habitat for Humanity" is a system that efficiently produces food such as higher plants (crops), microalgae, cultured meat, etc., and supplies them to residential areas.

(ii) The "Food Waste Management System (FWS)" is a system to recycle food residues and manure generated in residential areas as resources in the food production system through highly efficient recycling as liquid fertilizer and culture fluid by biological treatment, etc. The system is designed to be used as a food production system.

(iii) provides food solutions related to cooking and eating, in addition to observing QOL in residential areas, etc.

This business model is unique in that it is not limited to the mere supply of food, but focuses on ensuring quality of life from the perspective of risk management in extreme environments.

(2) Business Model Details

The Business Model Canvas created by the Food WG is shown below.

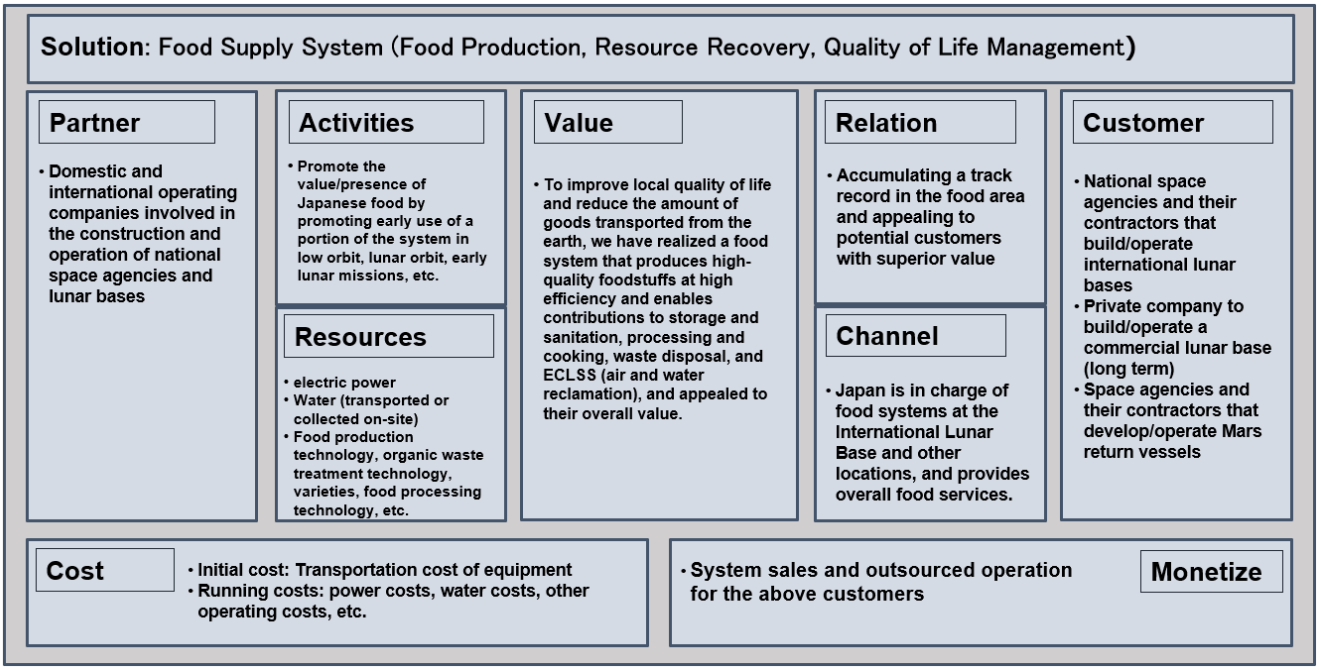


Figure 20: Business Model Canvas (Food WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

On the lunar surface, in addition to the large amount of transportation costs required, the frequency of transportation is limited, and the participants are expected to stay in a harsh closed and isolated environment, making it necessary to reduce supply fees, maintain the freshness of foodstuffs, and ensure QOL. Therefore, this business model aims to ensure QOL in extreme environments through highly efficient production of high-quality food ingredients and food solutions, and also to contribute to the reduction of material supply through highly efficient waste disposal and resource recycling.

(2) Customers

First of all, since the international lunar base is expected to be a national initiative, governments and space agencies of various countries are expected to be the customers. However, at some stage, a private sector-led

commercial lunar base is also envisioned, and in that case, the private sector companies that construct and operate the base are expected to be the customers.

(iii) Activities required

In order to realize this business model at the lunar base and gain a reasonable share of the market, it is necessary to enhance Japan's presence in the field of daily life in space, with food as a core element. In the short to medium term, the key to achieving this goal will be to create examples of food-related equipment (adoption) in low earth orbit and in the initial missions of the ARTEMIS mission.

(4) Partners needed

In realizing this business model, international space agencies and other domestic and foreign companies involved in the construction and operation of the lunar base will become partners.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Advanced Development ✓ Promotion of construction of demonstration fields such as simulated lunar base facilities, planning of design and operation plans, and ground demonstration of the developed integrated system ✓ Demonstration in space	✓ Securing public funds that can promote advanced development ✓ Construction of a simulated lunar base facility ✓ Ensure in-space demonstration opportunities
(2) Business aspects	✓ Japan's Low Presence in the Food Supply Sector	✓ Reaching consensus on Japan's contribution in the area of food supply
(iii) Legal policy aspects	✓ Inadequate rules for safety and health management ✓ Manned activities not yet contemplated in planetary protection regulations ✓ For QOL assurance and habitability Low priority related to	✓ Japan-led rule making

(1) Technical aspects

While the development of systems with high superiority is being promoted under the Strategic Program for Acceleration of Space Utilization (Stardust Program), from the perspective of maintaining and improving international superiority and technological maturity,
(i) advanced development, (ii) demonstration of the developed integrated system on the ground, and (iii) demonstration in space.

To this end, it is necessary to (i) secure public funds that can promote advanced development, (ii) construct a closed habitation experimental facility that will serve as a simulation of a lunar base for the purpose of continuous integrated demonstration of the food supply system, and (iii) secure opportunities for demonstration in space, including low Earth orbit and on the lunar surface. (iii) to secure opportunities for demonstration in space, such as low Earth orbit and on the lunar surface.

(2) Business aspects

As a business challenge, Japan's low presence in the field of food supply in space makes it difficult for Japan to be in charge of food supply at an international lunar base. In the future, it is desirable to reach an agreement with the U.S. and other countries on Japan's contribution to food supply in the context of the Artemis Accord, and an initial step may be to implement a Japan-originated food system on the manned pressurized rover that Japan is in charge of.

(iii) Legal policy aspects

As for legal and policy issues, first of all, since it is not assumed that food will be produced and consumed in space, or that resources will be regenerated through biological processing, there are no rules for safety and hygiene management. Therefore, it is necessary to clarify the rules for safety management, etc., and Japan should take the lead in rule making.

In addition, there is an issue that manned activities are not envisioned in the first place with regard to regulations on planetary protection in case of future implementation on Mars and other planets. Therefore, Japan should consider taking the lead in forming rules for local food production, while keeping a close eye on the revision of planetary protection regulations in accordance with the progress of plans for manned activities on Mars.

In addition, since the requirements for crew circumambulation have been defined by NASA standards based on the assumption that astronauts are selected for low Earth orbit stays, quality of life (QOL) assurance and habitability other than life support are given lower priority than in other areas. Japan should also consider taking the lead in updating the rules in these areas from the perspective of risk management, as a variety of crews are expected to stay in more severe environments in stages.

4.3.7 Finance and Insurance WG

(1) Business Model Overview

The business model considered by this WG group is to provide insurance that contributes to the realization of sustainable lunar surface development. Sustainable means the concept that both the operator and the insurance company cooperate with each other, and that the insurance company appropriately evaluates and manages the risks associated with the operator's activities so that both the operator and the insurance company can operate for the long term.

The space industry has a higher probability of accidents occurring and a greater impact when they do occur than other industries, making it difficult to continue business activities and creating high barriers to entry. For such a space industry, it is expected that insurance companies will support the continuation of business activities and increase the number of businesses by reducing the barriers to entry, thereby contributing to the development of sustainable lunar surface development. As a result, it is expected to contribute to the development of sustainable lunar surface development.

Since lunar surface development involves many unknown risks, it is important for insurance companies to be involved in the early stages of the project to accumulate knowledge on the risks.

(2) Business Model Details

The Business Model Canvas created by the Finance and Insurance WG is shown below.

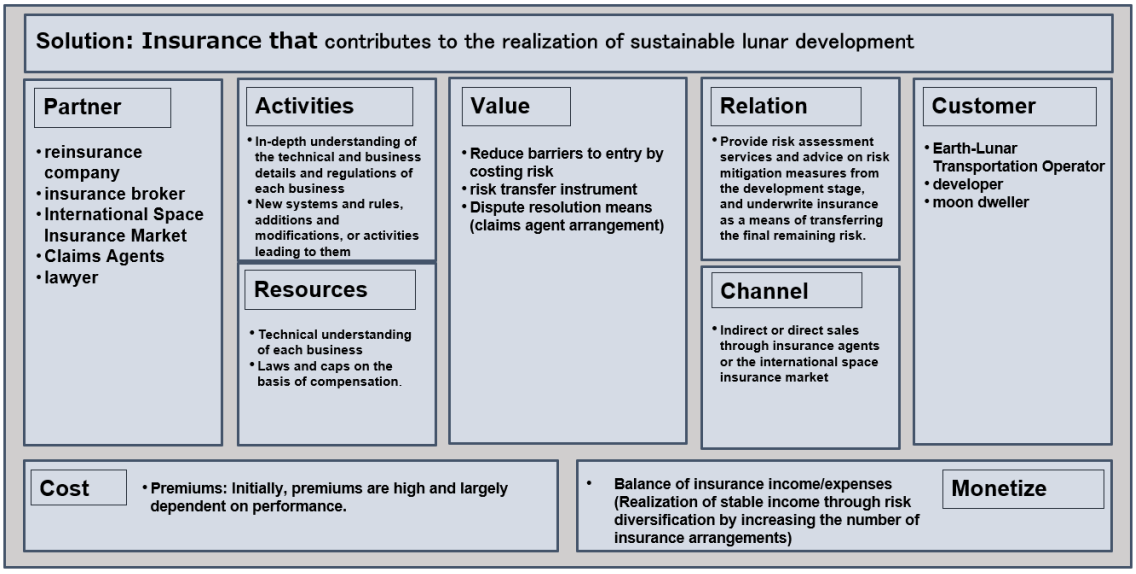


Figure 21: Business Model Canvas (Finance and Insurance WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

Insurance products can be broadly classified into two categories: (i) property insurance, which covers losses incurred by the insured (e.g., launch costs, lunar transportation costs, and manufacturing and development costs of lunar activity equipment) arising from accidents during transportation from ground launch to lunar landing and during lunar activities after landing, and (ii) third party insurance arising from business activities in lunar development, including

（The liability insurance covers compensation for bodily injury or damage to property (e.g., to other lunar surface developers) and litigation costs.

Many businesses in all WGs could be covered by insurance. However, the need for insurance may vary depending on the nature of the activity. In addition, depending on the nature of the activity, it may not be possible to underwrite insurance in the first place, so care should be taken regarding whether or not insurance can be provided.

(2) Customers

As mentioned above, since many businesses in all WGs will be targeted, the assumed customers in

this business model shall be all businesses involved in lunar surface development.

(iii) Activities required

In order to improve insurance underwriting capabilities (risk assessment) for lunar surface development, it is necessary to deepen understanding of both the technical and business details of each operator and the legal and regulatory environment related to these details.

If there are shortcomings in the environment, it will be necessary to establish new systems and rules, add to or modify existing systems and rules, or conduct activities that lead to these changes (e.g., providing opinions to the government in the case of laws), and develop uniform rules for international cooperation.

(4) Partners needed

Partners include reinsurance companies that underwrite a portion of high-cost policies such as space insurance on behalf of insurance companies, the international space insurance market, insurance brokers who connect carriers and insurance companies in the international space insurance market, and claims agents who respond locally to accidents that occur outside of their countries. In addition, there is a need for law makers to establish rules. In addition, the cooperation of lawyers will be needed for rule making.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Maturity of technology of operators ✓ Preparation of a standard property insurance policy for lunar surface development	✓ (None in particular)
(2) Business aspects	✓ Insufficient underwriting capacity ✓ Insufficient underwriting experience and accumulated knowledge ✓ Accident probability and volatility (variability) is large.	✓ Establish a government compensation program similar to space liability insurance
(iii) Legal policy aspects	✓ Absence of a government compensation system ✓ Regarding compensation for damages between private operators in outer space and on the Moon's surface Insufficient rules and regulations to be followed	✓ Japan-led rule making

(1) Technical aspects

As for technological issues, first of all, operators need to mature their technology to a level where insurance companies can underwrite insurance and improve the level of reliability, while insurance companies need to deepen their understanding of operators' technology to conduct appropriate underwriting. In addition, the environment needs to be improved, for example, by preparing standard non-life insurance policy clauses for lunar development.

However, these issues should be resolved by the insurance companies themselves, and are not specifically mentioned as policy recommendations.

(2) Business aspects

The business challenges include the fact that insurance companies do not have sufficient capacity to underwrite insurance, they do not have sufficient underwriting experience or accumulated knowledge, and they are highly volatile due to the probability of accidents occurring and the degree of impact when they do occur.

Government compensation programs could be a solution to these problems. The government compensation system can increase the number of insurance policies by compensating for the lack of insurance capacity, reduce the probability of accidents by ensuring the continuity of activities of operators and improving technological maturity, and reduce volatility by increasing the number of operators through the reduction of barriers to entry.

Therefore, it is desirable to establish a government compensation system for lunar development similar to the space liability insurance that launch operators are required to purchase. In designing the system, it is desirable that the government compensation should be a "fixed percentage" of the insurance amount to reduce unfairness in which the government compensation varies depending on the economic strength of the operator, and to suit the special characteristics of lunar surface development.

(iii) Legal policy aspects

As for legal policy and other environmental issues, there is a lack of or insufficient government compensation systems and related legislation to compensate for excess capacity in the private insurance market, international law regarding compensation for damages between private companies in outer space and on the Moon, treaties and international law regarding resources obtained from outer space and lunar surface development, and treaties and international law defining ownership rights for equipment and lunar architecture transported to the Moon. The lack of treaties and international laws defining the ownership of equipment transported to the Moon and lunar surface architecture are some of the issues that need to be addressed. We would like to request that these treaties and laws be established and maintained, including the issues mentioned in the technical and business aspects.

Turning to the international community, there is also a lack of uniform international rules, including soft law. It is clear that disputes over ownership and liability relationships will arise in the event of an actual accident. Insufficient organization of the underlying law makes it difficult to deal with insurance.

We would like the Japanese government to take the lead in rulemaking to establish uniform international rules.

4.3.8 Media and Entertainment WG

(1) Business Model Overview

The business model considered in this WG is to provide facilities and media related to the lunar business, as well as content.

Although we also considered content on the Moon, at this stage we decided to focus on content on the ground because we believe that the above business models should be realized before that.

(2) Business Model Details

The business model canvas created by the Media and Entertainment WG is shown below.

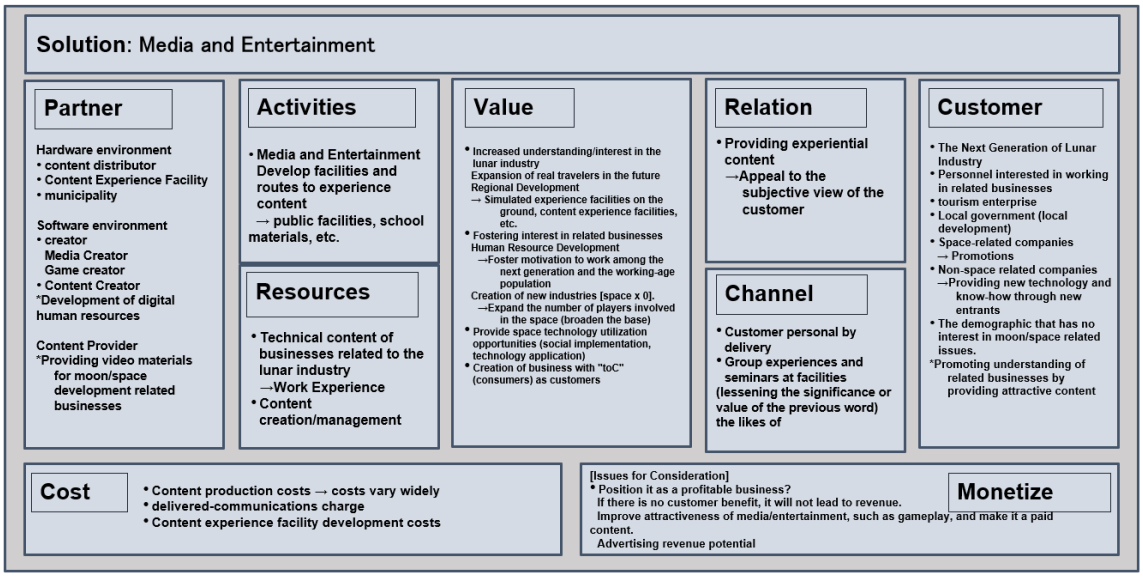


Figure 22: Business Model Canvas (Media and Entertainment WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The first objective of this business model is to deepen interest in the Moon and the lunar surface business. The Moon business is expected to expand rapidly in the future, and it is necessary to increase the number of human resources involved in this business. To realize this, first of all, it is necessary to create an environment where people of various generations, especially the next generation, can be interested in the Moon business from a cross-generational perspective. In addition, from a cross-industry perspective, it is necessary to create a momentum to encourage the participation of non-space business operators, broaden the base of players involved in the lunar surface business, and create a new approach to the lunar surface business.

In order to realize the above, it is desirable to develop the environment centering on certain facilities and locations, rather than each individual company working on its own. In this regard, there are facilities that can be the starting point of lunar business such as launch sites and spaceports, as well as vast land and sand dunes that are suitable for lunar business demonstrations in the regions. Therefore, these facilities and locations should be the center of the project, with the objective of regional development as well.

(2) Customers

The expected customers of this business model are directly the next generation of human resources and non-space business operators who have latent interest in the lunar surface business.

In addition, as mentioned above, since it is desirable to improve the environment around certain facilities and locations, local governments that have such facilities and locations could also be potential clients.

(iii) Activities required

In order to realize this business model, it is necessary to develop facilities and contents that enable people to experience the lunar business on the surface. Specifically, facilities and contents that enable people to experience life on the Moon by simulating life on the ground are considered.

(4) Partners needed

The first necessary partner would be a local government that has facilities and locations related to the lunar surface business. In this respect, local governments are both customers and partners.

In addition, for content, first of all, business operators such as creators who produce content are necessary, and business operators who distribute the content are also needed.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Metaverse, VR, and AR Technologies Level Immaturity	✓ Support for technical improvement
(2) Business aspects	✓ Difficulties in creating and developing content with continuity	✓ Implementation of Idea Contest ✓ Support up to the implementation stage
(iii) Legal policy aspects	✓ regarding the required image data. Restrictions on copyrights and other intellectual property rights	✓ To promote secondary use of image data Establishment of guidelines, etc. for

(1) Technical aspects

As for technological issues, the content must depend on the technological level of the metaverse, VR, and AR. Since metaverse, VR, and AR are naturally used for other purposes than content related to lunar business, the government may push for the improvement of such technology.

(2) Business aspects

One business challenge is that it is difficult to create and develop content that can be continued on an ongoing basis. For example, the government could conduct an idea contest for lunar-themed content and provide support up to the implementation stage.

(iii) Legal policy aspects

One legal policy issue is that image data required for content production and development is subject to copyright and other restrictions. Therefore, guidelines need to be further developed to promote secondary use of image data.

4.3.9 Tourism WG

(1) Business Model Overview

The business model considered in this WG is, first of all, to attract interest and expand new products and services to realize lunar travel.

Also, in the future, moon travel itself will become a business model.

(2) Business Model Details

The business model canvas created by the Tourism WG is shown below.

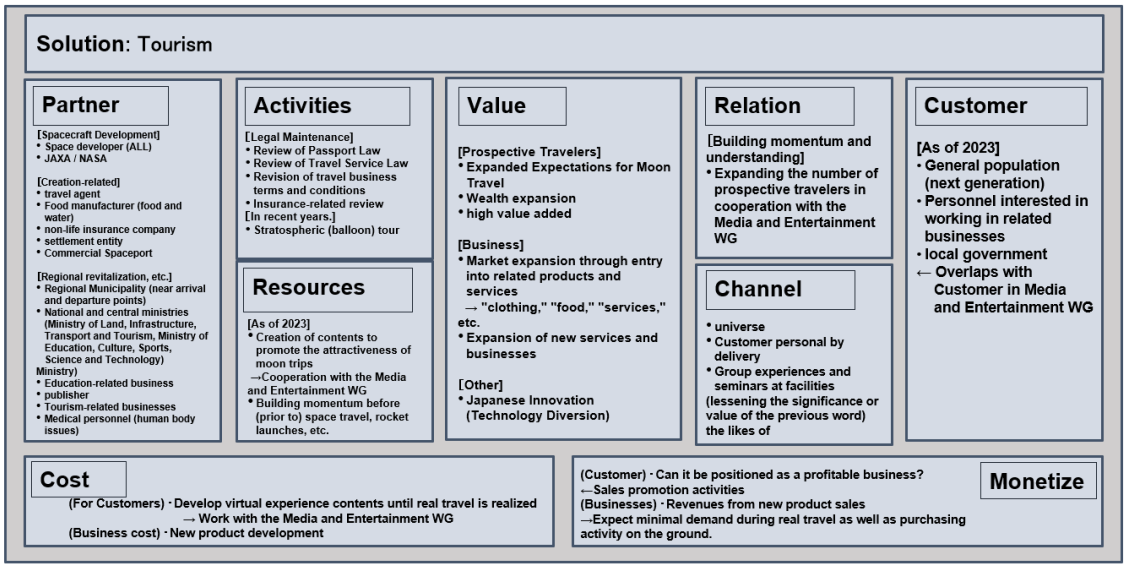


Figure 23: Business Model Canvas (Tourism WG)
(Source: Prepared by the Lunar Industry Vision Council)

(1) Purpose

The first objective of this business model is to deepen interest in the Moon and lunar business. In lunar travel, as in normal travel, the objective is not only to go to the destination, but the process to the destination will also be emphasized. Specifically, what kind of space suit to wear, what kind of food to eat, what kind of service to receive, etc. will be taken into consideration. Since it is difficult for only narrowly-defined space business operators to handle these issues, it is necessary to encourage the participation of non-space business operators, broaden the base of players involved in the lunar business, and expand the range of new products and services.

In order for lunar travel to become a reality, it is necessary to increase the number of human resources involved. Therefore, it is necessary to create an environment where people of various generations and industries, especially the next generation, can have an interest in the lunar business.

In addition, in local regions, there are facilities such as launch sites and spaceports that can serve as starting points for lunar business, as well as vast land and sand dunes that are suitable for demonstration tests of lunar business. The objective is also to promote regional development in cooperation with local governments that have facilities and locations related to lunar surface business in order to deepen interest in the Moon and lunar surface business.

(2) Customers

The customers envisioned for this business model are, first of all, people of various generations and industries who have a potential interest in the lunar business, especially in lunar travel.

From the perspective of regional development, local governments that have facilities and locations related to the lunar business could also be potential customers.

(iii) Activities required

In order to realize this business model, as mentioned above, it is necessary to create momentum to deepen interest in the Moon and lunar business.

In addition, when moon travel becomes a reality, the Travel Agency Law and the Passport Law will need to be revised, and travel agency clauses and travel insurance policies will also need to be reviewed. In this connection, although not space travel itself, some companies have been planning to take balloons to the stratosphere in recent years, and it is likely that legal revisions will be necessary at some point.

(4) Partners needed

Necessary partners include media and entertainment companies, education-related companies, publishing companies, and tourism-related companies, in order to attract interest in the Moon or lunar business. In addition, the expansion of new products and services will require the development of non-space business partners, such as clothing-related companies for the development of space suits, and food-related companies for the development of space food.

From the perspective of regional development, local governments that have facilities and locations related to the lunar business could be considered, and local governments could be both customers and partners.

In addition to travel agents, cooperation with insurance companies and lawyers will be necessary when lunar travel is realized.

(3) Issues and Policy Recommendations

	issue	policy advocacy
(1) Technical aspects	✓ Improvement of technology related to lunar travel	✓ Clarification of policy to ensure manned transportation to the Moon ✓ Securing Demonstration Opportunities
(2) Business aspects	✓ Roadmap for Moon Travel Opacity of	✓ Secure manned transportation to the Moon. Clarification of policy to the effect that
(iii) Legal policy aspects	✓ Lunar and Space Travel Inadequate maintenance of rules	✓ Japan-led rule development

(1) Technical aspects

As for technological issues, it is necessary to improve overall technologies related to lunar travel. In particular, since the spacecraft will be manned, it will be necessary to establish the safety and reliability of the spacecraft and to understand the effects on the human body in space. To address these issues, Japan should establish a policy to secure manned transportation means to the Moon, and secure opportunities for demonstration.

(2) Business aspects

One business challenge is the lack of a roadmap for lunar travel and, consequently, the low level of predictability. Therefore, as mentioned above, it is necessary for Japan to establish a policy to secure manned transportation to the Moon in order to create a situation where private companies can easily enter the Moon travel business.

(iii) Legal policy aspects

One of the legal and policy challenges is that there are no unified common rules for lunar or space travel in all countries of the world. In particular, there are only a few existing rules for professional astronauts, and none for civilians. In addition, as for domestic laws, the Travel Agency Law and the Passport Law need to be revised. Japan, which has a certain advantage in lunar surface development, should actively lead the discussion on this point.

4.4 summary

The business models studied by each WG are described above, but looking at the overall picture, it can be noted that each business model has common issues, etc., as described below. It should be reiterated that each business model is not independent of the others, but rather complementary to each other.

Policy recommendations include providing opportunities for lunar surface demonstration to the private sector, launching an industrialization support program based on the provision of lunar surface demonstration opportunities, and establishing facilities that simulate the lunar environment and a lunar base.

Policy recommendations to address this issue include support for business startups through continuous government procurement, and the development of needs through the promotion of data utilization. Another challenge is the need to cooperate with other countries while competing with them. Policy recommendations include joint operation of facilities with other countries and the establishment of groups and organizations to negotiate on equal terms with other countries.

In terms of legal policy, there are issues such as the lack of rules and the unclear scope of responsibility of each player (operators, customers, and the government).

In order for the lunar industry to develop independently, the government needs to support the industry, but at the same time, it is necessary for private enterprises to help themselves.

5 Conclusion

This vision, compiled by the Lunar Surface Industry Vision Council (attached), which is comprised of government, academia, and industry, is similar to the "Lunar Surface Industry Vision - Toward Planet 6.0 Era" released in June 2021, and demonstrates industry's determination to take the initiative in forming new industries in this lunar space and creating innovation on Earth through value return. It also calls on the government to work together to realize this future.

More than three years have already passed since the vision was announced, during which time there has been progress in government-related activities, including the success of NASA's Artemis 1, DARPA's LunA-10, India's successful landing of Chandrayaan-3 on the Moon, progress in China's Chang'e mission, and Japan's SLIM, the world's first successful pinpoint landing on the Moon. In addition, significant progress was also made in the activities of private companies, such as ispace's attempt to land on the Moon and Intuitive Machines' first successful soft landing on the Moon by a private company. In addition, the Lunar Surface Innovation Consortium (LSIC) in the U.S. and Euro2Moon in Europe have been working to promote lunar exploration and the creation of a lunar industry in the form of consortiums overseas. Euro2Moon has approached the Council to collaborate, and there are moves to seek mutual collaboration. In addition, with regard to rule making, which is a prerequisite for business, there is a need for the development of national laws in each country and a political agreement led by the U.S., which is expected to be implemented in the near future.

In addition to the "Artemis Accord" and other agreements, the United Nations established a WG in 2023 to study international rules for space resources, and representatives from countries around the world have begun discussions based on a five-year work plan.

The Council has also held two lunar business conferences since the release of the vision, and has worked to foster a movement toward the creation of lunar businesses by publicizing the results of the Council's deliberations and proposals to the government. In addition, nine working groups were formed according to the fields of interest of the member companies: "Earth-Moon Transportation," "Construction and Infrastructure," "Information and Communication," "Resources and Energy," "Lunar Transportation," "Food," "Finance and Insurance," "Media and Entertainment," and "Tourism," to discuss issues and solutions for the materialization and realization of lunar surface business. The WGs discussed and examined issues and solutions for the materialization and realization of lunar business, and organized them into technical, business, and legal aspects. In addition, the WGs have held joint events to promote collaboration and mutual understanding with the scientific community.

As for moon-related activities other than the Council, the Stardust Program has been promoted by relevant ministries and agencies, and the Basic Plan for Space Policy revised in June 2023 includes a significant increase in the use of the keyword "lunar surface" and the phrase "lunar economic zone," etc. The focus on the moon in Japan is steadily increasing. The Moon has been attracting increasing attention in Japan. In addition, the "Space Technology Strategy" released in March 2024 also identifies "energy technology," "lunar communications and positioning technology," "lunar resource development/utilization technology," and other technologies that will lead to lunar industries as important technologies for "lunar exploration and development," and the "Space Strategy Fund" has begun soliciting public participation in the development of related technologies. The "Space Strategic

Fund" has also begun soliciting applications for the development of related technologies. In addition to government activities, the Moon Village Symposium held in Kurashiki in December 2023 was attended by 180 people, even though it was held outside of the Tokyo metropolitan area, confirming the growing interest in lunar business. This confirms the growing interest in the lunar business. In addition, more than 270 companies have expressed interest in the lunar industry by participating in related communities and participating in or supporting government projects or private-sector independent activities, a significant increase from the time the vision was announced.

Thus, since the release of the "Lunar Industry Vision - Toward the Planet 6.0 Era", many items related to the lunar industry have been realized, materialized, and detailed, including those other than the six resolutions and seven recommendations in the Vision. In response to major changes in the external environment, such as changes in policies, including the Space Basic Plan, the Space Technology Strategy, and the Space Strategic Fund, the improvement of lunar business resolution through discussions in the WGs within the Council, and progress in cooperation with the scientific community and overseas communities, the Council has revised the "Lunar Industry Vision - Toward the Planet 6.0 In response to these changes, the Council has decided to revise the "Lunar Surface Industry Vision - Toward the Planet 6.0 Era" and publish a new "Lunar Surface Industry Vision 2024". The newly released "Lunar Surface Industry Vision 2024" is a compilation of seven resolutions and seven recommendations, both continuing and new, based on the status of achievement of the resolutions and recommendations in the previous vision and the results of discussions and deliberations within the Council. This vision is not intended to ask the government for all the funds necessary to realize the lunar industry, as was the stance taken in the "Lunar Industry Vision - Toward Planet 6.0 Era", but rather to provide a framework for the industry to autonomously implement and develop lunar business, including measures based on Article 16 of the Basic Space Law "Promotion of Space Utilization by Private Business Operators". The purpose of this document is to request the government to improve the business environment, including measures based on Article 16 "Promotion of Space Utilization by Private Business Operators" of the Basic Act on Space Policy.

Seven Industrial Resolutions:

Resolutions 1.[Continuation]

In preparation for an era in which the private sector will take the lead, we will identify where industry's strengths are needed and utilized in government programs and private sector-led activities, and we will take our own risks to improve our technologies and capabilities so that we can lead the world in lunar orbit and lunar surface business development.

Determination 2. [Underlining added and continued].

The Moon's surface will be utilized as a site for technological and social demonstrations to create new technologies and social systems, as well as to bring valuable innovations to the Earth and existing industries in Earth orbit.

Determination 3. [Continuation]

In the period when the private sector took the lead, the "transportation sector (Earth-Moon, lunar surface)" and the "information and communication sector,

We will conduct lunar business for private companies and domestic and foreign governments in a variety of fields, including media/contents, resources/energy, construction/infrastructure, food, finance/insurance, and tourism.

Determination 4. [New]

In order to establish the basic infrastructure required for lunar surface development in the next 10～20 years, the private sector will be involved in the construction of the infrastructure and elemental technologies for the necessary systems such as "transportation (Earth-Moon, Moon)", "resources and energy", and “information and communication", as a world pioneer, through early ground-based demonstration, low orbit of commercial space stations, and technology demonstration on the Moon. The technologies will be demonstrated on the ground, in low orbit on the commercial space station, and on the Moon's surface.

Determination 5. [New]

The private sector will take the lead in acquiring, analyzing, and providing opportunities to utilize lunar data on resources and the lunar surface, which will serve as the basis for planning and reviewing all lunar surface activities.

Resolution 6. [Integrate and continue]

The rules and legal systems that are necessary to develop business ahead of the rest of the world are listed in detail, and the effects if enacted or the risks if not enacted are shown. In addition, the report will develop a set of norms/codes that industry should follow in developing and utilizing the Moon (e.g., adherence to environmental protection and peaceful use of the Moon, sustainable development and utilization of the Moon from a trans-terrestrial perspective, etc.), we will strive to spread the word.

surface activities.

The Lunar Module will develop and disseminate a code of conduct (e.g., adherence to environmental protection and peaceful use of the Moon, sustainable development and use of the Moon from a trans-terrestrial perspective, etc.) that industry must follow when developing and utilizing the Moon.

Determination 7. [New]

The objective is to create a virtuous circle through the synergy effect of cooperation between the scientific and industrial communities that are both aiming for the Moon. The development of knowledge, data, and observation instruments by the scientific community will help build the lunar industry; missions and services by the private sector, whose technologies and capabilities have been improved through participation in scientific projects, will expand research opportunities and promote advancement and diversification of research by the scientific community; and the private sector will participate in new scientific projects. The private sector will also participate in new scientific projects, thus building an industrial base for sustainable lunar surface development through collaboration among communities rather than one-off projects.

Seven recommendations to the government:

Seven Recommendations to the Government:

Recommendation 1. [Continued with additions and changes to underlined parts].
The government should widely monitor the trends of technological and business development on the Moon by private companies in various industries, and assume the procurement of private sector services to build an ecosystem for the lunar surface industry. The government should take into account various activities such as transportation, exploration, and infrastructure construction to the Moon's surface and lunar orbit. To this end, the policy significance of the Moon and lunar industry should be clarified with a view to its linkage with existing industries on the Earth and in Earth orbit, and government plans and policies for lunar activities, including the Artemis Plan, should be organized in a visible manner to enhance the predictability of the private sector.

Recommendation 2. [Continuation]
In order to reduce the cost of access to the Moon, the government should be a provider of transportation opportunities for the private sector to conduct lunar commercial activities, utilizing both public and private sector lunar missions. For government missions, the government should provide carpooling opportunities to the private sector by utilizing excess space on the Moon transfer launch vehicle. For private missions, the private sector will provide transportation opportunities to the Moon's surface and lunar orbit as a service.

Recommendation 3. [Underlining added and continued].
The government should strive to create an environment to accelerate the private sector's business development for the Moon business by taking risks on their own. The government should also work to establish programs and venues for the creation of new lunar industry businesses and entrepreneurs, implement programs to promote the flow and transfer of human resources, knowledge, and technology, establish a simulated test environment (digital twin, etc.) using the latest lunar surface data that will be measured in the field, and develop a deep-space geo-transmission infrastructure. The following are some of the activities that will be undertaken.

Recommendation 4. [New]
In order to quickly realize the construction of the lunar surface infrastructure (transportation, resources/energy, information/communications, etc.), in which the private sector will take the initiative, the government should support ground demonstrations in special zones with relaxed communication and radiation standards, and provide opportunities for initial demonstrations in low Earth orbit and on the Moon's surface.

Recommendation 5. [New]
In addition to data acquired by the government, the acquisition and analysis of lunar data by the private sector should be supported and actively utilized to further promote lunar activities such as lunar resource exploration and development, transportation on the Moon, and design of basic infrastructure. To this end, the government should support the development of sensors and other technologies and purchase private-sector services.

Recommendation 6. [Continuation]
The government will promptly develop the necessary systems, guidelines, standards, etc. to give the Japanese private sector a competitive advantage, and will cooperate and collaborate with the international community to develop rules to ensure international commercial activities (e.g., communication bandwidth, construction standards, safety zones, codes/ norms to be followed by the industry, etc.),

e.g., the "Lunar Business Support Program"). Through these activities, the Moon Business Association will be recognized as a country that is proactive in supporting the Moon business.
The goal is to attract foreign companies by increasing their visibility, and to become a center for the world's most advanced information, while paying attention to the outflow of information overseas.

Recommendation 7. [New + continued underlining].
Clarify in policy that collaboration and complementarity between the scientific and industrial communities have various effects on both scientific exploration, including the three lunar sciences, and the formation and enhancement of the industrial ecosystem. In addition, in order to enhance the synergistic effects of collaboration between lunar science and lunar industry, measures should be taken to establish a platform for collaboration between the two communities, develop cooperative programs, and promote the use of private facilities and services in scientific programs.
Furthermore, these activities should be linked to the development of next-generation human resources and higher education.

As mentioned above, policy attention to lunar surface development has increased significantly since the previous vision was released, and the industry is encouraged by the fact that the government and the industry are on the same page. The Moon's surface is still a blue ocean area compared to Earth orbit, which is a red ocean where competition among countries is fierce, and it is positioned as a frontier area for the next generation. Japan is ahead of other countries in all aspects of policy, science, and industry, including the enactment of the Space Resources Act, the formulation of a space technology strategy, and the establishment of the Space Strategic Fund; in science, the successful SLIM pinpoint landing and night landing; and in industry, more than 270 private companies have started lunar industry related activities. On the one hand, SLIM is ahead of other countries in all aspects of policy, science, and industry. On the other hand, some of the R&D results of the Stardust Program have not been carried over to later programs. In order to lead as a front runner by taking advantage of our leading position, and to create a "lunar industrial revolution" that will lead the world in the creation of new industries led by the private sector on the lunar surface, it is essential to further strengthen activities related to the lunar surface, not to stop at this point.

This vision is a statement of industry's determination to take the initiative in forming new industries in lunar space and creating innovation on Earth through value return, and a request to the government to work together to realize this future. The vision is not static and should be reviewed in response to changes in circumstances, and will be updated as necessary.

... and upwards

Lunar Industry Vision Council Members (in order of organization name) (as of September 30, 2024)

chairman	Takeo Kawamura	Special Assistant to the Vice President, Liberal Democratic Party
	Atsushi Kado Minami	President, The Sasakawa Peace Foundation
acting chairman	Keitaro Ohno	member of the House of Representatives
	Takayuki Kobayashi	member of the House of Representatives
	Karen Makishima	member of the House of Representatives
	Takahiro Nakamura	CEO and Representative Director, Midtown Co.
	Tetsuya Hanyu	Executive Officer, Mitsubishi Research Institute, Inc.
	Takeshi Hakamada	CEO and Representative Director, ispace Inc.
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	Naohiro Kitamura	deputy general manager President, Japan Space Law Association Attorney at Law, IGT Law Offices
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	Yasuto Sekine	Professor, Institute for Earth and Life Research, Tokyo Institute of Technology
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	Katsuaki Tanaka	Representative Director, amulapo Inc.
	Hideo Sukimoto	President, Space Development Cooperative SOHLA
	Yasuhiro Fuchida	General Manager, Future Technology Creation Department, Technology Division, Obayashi Corporation
	Ken Tsutsui	Kawasaki Heavy Industries, Ltd. General Manager, Space Systems Design Department
	Yusuke Watanabe	GT Tokyo Law Office Attorney at Law
	Naohiro Uyama	Chief, Space Development Department, Frontier Development Office, Shimizu Corporation
	Mizuki Komasa	General Incorporated Association SPACE FOODSPHERE
	Seiichi Yamada	Representative Director, Manager, Space Technology Strategy Team, Taisei Corporation
	Hiroyuki Muraoka	
	Noriaki Hotta	Executive Officer, Takasago Thermal Engineering Corporation
	Mitsuhiko Goto	General Manager, Carbon Neutral Business Development Department, Research & Development Division General Manager, Space Business Department, Chiyoda Corporation
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	Hiroshi Takeshita	Director, Manned Space Systems, Inc.
	Kengo Suzuki	Co-Founder and Executive Fellow, Euglena Co.
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