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**Catalyzing Space Ecosystems: The Role of Space Enablers
and Multi-Stakeholder Networks
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Abstract

As humanity moves toward a future of expanding space activities beyond Earth, participation in the space economy must extend beyond the traditional group of spacefaring nations. Around the world, new regions are beginning to explore how they can take part in this growing industry. Building a space ecosystem, however, rarely begins with large national programs. More often, it starts with motivated individuals or small groups who recognize opportunities and begin connecting stakeholders across government, academia, industry, and civil society.

This paper explores how inclusive space ecosystems can emerge through catalytic actions taken by different stakeholders. Examples from several countries illustrate how governments, universities, companies, and non-profit organizations have each played leading roles in initiating space-related initiatives within their regions. These efforts are often sparked by “space enablers” - individuals or communities who act as conveners and advocates for participation in space activities.

The paper will highlight common patterns observed in emerging ecosystems and discuss simple ways communities can begin identifying their own strengths and opportunities. By sharing practical examples from around the world, the session aims to demonstrate how inclusive participation in space can be fostered and how even small initiatives can contribute to the development of a dynamic global space ecosystem.

1. Introduction

As humanity moves toward a future of expanding space activities beyond Earth, participation in the space economy is increasingly extending beyond the traditional group of spacefaring nations. Around the world, emerging regions are beginning to explore how they can participate in this rapidly evolving industry through applications in communications, Earth observation, climate monitoring, agriculture, disaster management, advanced manufacturing, and scientific research.

Historically, space activities were dominated by large government programs requiring extensive national budgets, infrastructure, and decades of institutional development. However, the emergence of the commercial “New Space” economy has significantly lowered barriers to participation. The rise of small satellites, reusable launch systems, commercially available Earth observation data, open-source technologies, and global digital collaboration

has enabled a broader range of countries, institutions, and entrepreneurs to engage in space-related activities.

As a result, many regions are now seeking ways to build local space ecosystems. Yet successful ecosystems rarely begin with large national agencies or billion-dollar investments. More commonly, they emerge gradually through the efforts of motivated individuals, small organizations, universities, startups, and community leaders who identify opportunities and begin connecting stakeholders across sectors.

The observations presented in this paper are based largely on the authors' direct experiences over the past decade working with emerging and developing space ecosystems through workshops, competitions, startup mentorship, ecosystem assessments, and international collaborations across multiple countries and stakeholder groups. Rather than proposing a rigid model for ecosystem creation, this paper argues that successful ecosystem development is highly contextual, multi-stakeholder in nature, and often initiated through relatively small catalytic activities.

This paper explores how dynamic and inclusive space ecosystems can emerge through catalytic actions taken by governments, academia, industry, non-profit organizations, and community networks. It further examines the role of "space enablers" - individuals or groups that act as connectors, conveners, advocates, and translators across stakeholder communities. Through comparative case studies and practical examples, the paper demonstrates that sustainable ecosystem development is fundamentally a multi-stakeholder process and that even small initiatives can contribute meaningfully to the development of a broader global space economy.

2. Understanding Space Ecosystems

A space ecosystem can be understood as a network of interconnected stakeholders working toward shared value creation through space-related activities, enabled by infrastructure, policy, investment, and culture. Rather than focusing solely on launch capabilities or national space agencies, a space ecosystem encompasses the broader environment that supports innovation, entrepreneurship, education, research, and collaboration.

A healthy ecosystem typically includes several interdependent stakeholder groups:

- Government institutions that provide policy, regulation, and strategic direction;
- Industry actors that execute commercial activities and create market demand;
- Universities and research institutions that develop talent and conduct research;
- Investors and funding organizations that provide capital;
- Support services such as legal, insurance, consulting, and business development;
- NGOs and community organizations that foster inclusion, awareness, and outreach;
- Physical and digital infrastructure including launch facilities, laboratories, communications systems, and data platforms.

Importantly, no single stakeholder can build a sustainable ecosystem alone. Ecosystem development depends on the alignment and interaction between multiple actors. Fragmentation between stakeholders often slows growth, while collaboration accelerates innovation and capability development.

The concept of a space ecosystem also extends beyond the traditional aerospace sector itself. In many emerging regions, space activities are closely tied to adjacent industries such as:

- agriculture,
- climate technologies,
- artificial intelligence,
- robotics,
- telecommunications,
- maritime industries,
- geospatial analytics,
- autonomous systems, and
- advanced manufacturing.

This interconnectedness means that ecosystem development frequently emerges not from a standalone “space industry,” but from the convergence of multiple sectors responding to common technological and societal challenges.

Unlike traditional top-down industrial development models, ecosystems are dynamic and adaptive. They evolve through relationships, trust-building, experimentation, and iterative growth. In many emerging regions, the earliest stages of ecosystem formation begin socially and informally before becoming institutionalized through government support, formal programs, or commercial investment.

3. Why Space Ecosystems Matter

The growing importance of space ecosystems reflects the ongoing transition from government-dominated space activities toward a more distributed and commercial global industry. Space technologies increasingly underpin critical sectors of the modern economy, including telecommunications, navigation, precision agriculture, environmental monitoring, logistics, defense, and financial systems.

For emerging and developing nations, participation in the space economy offers several strategic benefits:

- Economic diversification and development of high-value industries;
- Creation of STEM education pathways and advanced technical capabilities;
- Increased access to satellite data and communications infrastructure;
- Greater technological sovereignty and national resilience;
- Integration into international innovation and supply chains;
- Opportunities for youth engagement and talent retention.

Space ecosystems also generate significant spillover effects into adjacent sectors. Investments in satellite engineering, autonomous systems, software development, AI, sensors, and advanced manufacturing frequently support innovation far beyond the space industry itself. In many cases, the process of building a space ecosystem becomes a broader catalyst for national innovation capacity.

Another increasingly important aspect is inclusion. Historically, participation in space activities was limited to a small number of major powers. Today, however, smaller countries,

universities, startups, and NGOs can contribute meaningfully through specialized capabilities, partnerships, and entrepreneurial initiatives.

This democratization of participation has significant implications for the future global space economy. The expansion of access enables broader diversity of perspectives, applications, and problem-solving approaches. It also creates opportunities for developing nations to participate not merely as consumers of space technology, but as contributors and innovators within the global ecosystem.

4. The Role of Space Enablers

One of the most important but often overlooked components of emerging ecosystems is the role of the “space enabler.” A space enabler may be an individual, organization, network, or informal community that catalyzes ecosystem development by connecting stakeholders, creating opportunities, and initiating collaborative activity.

While space agencies, governments, and corporations often receive the greatest visibility, many ecosystems initially emerge through the efforts of passionate individuals or small groups operating without formal authority or large financial resources. These actors frequently serve as the connective tissue between otherwise fragmented communities.

Space enablers typically perform several important functions.

4.1 Convening Stakeholders

In many emerging ecosystems, stakeholders initially operate in isolation. Universities may not know local startups, policymakers may not understand commercial opportunities, and investors may have limited exposure to the space sector. Space enablers help bridge these gaps by organizing events, facilitating introductions, and building trust networks across sectors.

Meetups, conferences, workshops, and networking events often become foundational mechanisms for community formation and relationship-building. In many cases, the first major outcome of ecosystem-building activities is not technology development itself, but simply the realization among stakeholders that a broader community exists.

4.2 Translating Between Communities

Space ecosystems involve highly diverse stakeholders with different priorities, languages, and operational cultures. Space enablers frequently act as translators between technical, governmental, academic, and commercial communities.

For example, they may:

- explain technical concepts to policymakers,
- help startups understand regulatory requirements,
- connect researchers with commercial opportunities, or
- communicate investment opportunities to financial institutions.

This translational role is especially important in emerging ecosystems where institutional knowledge may still be limited and where space activities intersect with non-space sectors unfamiliar with aerospace terminology or processes.

4.3 Catalyzing Initial Activities

Ecosystems often begin with relatively small activities that create visibility and momentum. These include:

- hackathons,
- challenge competitions,
- educational workshops,
- mentorship programs,
- public outreach initiatives, and
- collaborative pilot projects.

Such activities create low-barrier entry points that rapidly engage participants, identify talent, and attract broader stakeholder interest. They also help demonstrate visible progress, which can be important for maintaining momentum in early-stage ecosystems where resources remain limited.

Importantly, these activities do not necessarily require large budgets or sophisticated infrastructure. In many cases, the willingness to organize and convene is more important than the availability of funding.

4.4 Building Credibility and Momentum

As early activities demonstrate success, ecosystems begin attracting institutional support, funding, and political attention. Based on observations across multiple emerging ecosystems, a common development pattern often emerges:

1. Awareness
2. Community formation
3. Initial activities
4. Institutional support
5. Industry growth
6. Sustainability

This “ecosystem development pathway” is not necessarily linear, nor does every ecosystem progress at the same speed. However, the pattern illustrates an important observation: ecosystems frequently begin socially before they become institutionally formalized.

In many regions, community-building and relationship development precede formal policies, government agencies, or major commercial investments. Over time, successful activities generate credibility that attracts broader stakeholder participation and long-term support.

5. Comparative Ecosystem Development Models

Different regions have developed space ecosystems through different stakeholder-driven pathways. The following examples illustrate how various actors can serve as the initial catalyst for ecosystem growth.

5.1 Government-Led Development: Luxembourg

Luxembourg provides a strong example of a government-led ecosystem strategy. Despite its small geographic size, Luxembourg positioned itself as a major participant in the emerging space resources economy through deliberate national policy, investment incentives, and legal innovation.

The Luxembourg government established a national space strategy and implemented legal frameworks supporting commercial ownership and utilization of space resources. It also invested heavily in attracting companies, startups, and international partnerships related to space resources and advanced space technologies.

Institutions such as the Luxembourg Space Agency and the European Space Resources Innovation Centre (ESRIC) further reinforced this strategy by supporting research, entrepreneurship, and international collaboration.

Luxembourg demonstrates how strategic policy and regulatory leadership can rapidly catalyze industry growth and position a small nation within a specialized global niche. The ecosystem also illustrates how governments can intentionally create favorable conditions that attract private sector participation and international investment.

5.2 Academia-Led Development: Philippines

The Philippines demonstrates how universities and educational institutions can seed ecosystem development. University-led CubeSat programs and international academic collaborations helped develop local technical talent and research capabilities before the establishment of a formal national space agency.

A particularly important aspect of the Philippine ecosystem's early development was the role of international academic collaboration. Anecdotally, leaders within the Philippine Space Agency have described how the initiative began through a collaboration between professors in the Philippines and Japan. This partnership enabled Filipino engineers and researchers to travel to Japan to participate directly in the development of the country's first satellites while receiving hands-on training and technical experience.

Beyond the technical outcomes, this collaboration served as a mechanism for knowledge transfer, mentorship, and capability-building. The engineers who participated in these early projects later returned to the Philippines and became part of the foundation for subsequent satellite programs. Over time, this contributed to the development of increasingly sophisticated in-country satellite design and engineering capabilities.

Academic initiatives therefore provided more than educational opportunities; they created a pathway for long-term ecosystem formation by developing human capital, institutional confidence, and international partnerships simultaneously. These activities not only built technical capability but also generated national awareness and legitimacy for the country's emerging space sector.

Over time, these educational and collaborative efforts contributed to broader policy momentum and eventually supported the creation of the Philippine Space Agency (PhilSA).

The Philippines illustrates how education, international collaboration, and talent development can collectively serve as foundational building blocks for national ecosystem growth. Importantly, academic ecosystems often create long-term multipliers, as students later become researchers, entrepreneurs, policymakers, and industry leaders within the ecosystem itself.

5.3 Industry-Led Development: New Zealand

New Zealand represents an industry-led ecosystem model driven largely by the success of Rocket Lab. The company's emergence as a globally recognized launch provider created significant momentum for the country's broader aerospace and space sectors.

Rocket Lab's success attracted international attention, investment, suppliers, technical talent, and government interest. In response, New Zealand developed supporting regulatory frameworks, educational initiatives, research partnerships, and industry associations.

The presence of a strong anchor company also stimulated entrepreneurial activity across adjacent sectors including advanced manufacturing, software, aerospace engineering, robotics, and satellite applications.

New Zealand demonstrates how commercial success can legitimize an emerging industry and accelerate ecosystem growth. However, it also illustrates that long-term sustainability still depends on broader ecosystem participation across academia, government, community organizations, and investors.

5.4 NGO-Led Development: Maldives

The Maldives provides an example of grassroots ecosystem development through the Maldives Space Research Organization (MSRO). Unlike many traditional models, this initiative began without major infrastructure, government agencies, or large budgets.

Instead, the organization focused initially on awareness-building, education, community engagement, and international networking. Through conferences, outreach activities, and public engagement, MSRO helped establish an international conversation around space opportunities for island nations.

The Maldives case demonstrates that ecosystem development can begin through grassroots community-building and advocacy long before formal infrastructure exists. It highlights an important principle: participation in the space economy does not require waiting for permission or large-scale institutional support to begin.

6. Catalyzing Activities and Practical Interventions

Many ecosystem-building activities share common characteristics: they are relatively low-cost, highly collaborative, and capable of generating rapid engagement. Examples include:

- meetups,

- hackathons,
- challenge competitions,
- workshops,
- training programs,
- mentorship initiatives, and
- international partnerships.

These activities are effective because they:

- lower barriers to entry,
- identify emerging talent,
- create visibility,
- foster collaboration,
- build trust, and
- encourage experimentation.

One example is the ecosystem-building work conducted by SpaceBase in New Zealand over the past decade. Activities included challenge competitions, workshops, podcasts, newsletters, networking events, startup mentorship, public outreach, industry convening, and ecosystem mapping exercises.

Challenge competitions and hackathons are particularly powerful tools because they rapidly bring together students, entrepreneurs, researchers, and industry professionals around real-world problems. Educational workshops and training programs similarly help participants assess regional capabilities, identify opportunities, and develop actionable strategies for ecosystem growth.

Workshops conducted by the authors between 2020 and 2022 examined ecosystem opportunities across 23 countries and highlighted recurring themes among participants. Common priorities included:

- establishing national space policies,
- strengthening STEM education,
- creating industry-academia partnerships,
- improving access to funding,
- building public awareness, and
- developing national coordination mechanisms.

These observations suggest that many emerging ecosystems face similar foundational challenges despite significant differences in geography, economic development, and political structure.

Most importantly, such activities effectively create “social infrastructure” before major physical infrastructure exists. They build the relationships, trust, collaborative culture, and visibility necessary for long-term ecosystem sustainability.

7. Tools for Ecosystem Development

Emerging ecosystems should avoid attempting to replicate existing spacefaring nations directly. Each region possesses unique strengths, constraints, opportunities, and cultural

contexts. Instead, ecosystem development should begin with understanding the local environment and identifying realistic leverage points.

Two useful analytical tools are:

- SWOT analysis (Strengths, Weaknesses, Opportunities, Threats), and
- PESTLE analysis (Political, Economic, Social, Technological, Legal, Environmental).

These frameworks help communities identify:

- existing capabilities,
- adjacent industries,
- policy gaps,
- talent shortages,
- funding constraints, and
- potential international partnerships.

Common ecosystem bottlenecks include:

- limited investment capital,
- fragmented stakeholders,
- lack of technical talent,
- weak policy frameworks,
- absence of anchor institutions, and
- insufficient public awareness.

At the same time, many regions possess underutilized leverage points such as:

- universities,
- strong STEM education,
- manufacturing capability,
- software expertise,
- geographic advantages,
- natural resources, or
- international diaspora networks.

A critical observation from ecosystem workshops and engagements is that many regions underestimate their own existing capabilities because they compare themselves directly to mature ecosystems such as the United States, Europe, or Japan. However, ecosystem development rarely begins with full vertical integration. More commonly, successful ecosystems emerge by identifying niche opportunities where local strengths intersect with global demand.

Another important consideration is intentional inclusivity. Future space ecosystems should seek broad participation across gender, geography, socioeconomic backgrounds, and disciplines. Diversity within ecosystems increases resilience, creativity, and long-term sustainability.

Ultimately, effective ecosystem development requires strategic focus on local comparative advantages rather than attempting to duplicate other national models.

8. Future Directions for Emerging Ecosystems

As the global space economy continues to evolve, emerging ecosystems may increasingly benefit from distributed international collaboration rather than attempting to independently develop every capability domestically. Advances in digital collaboration, cloud infrastructure, AI-assisted engineering, open-source software, and commercial space services are making participation more accessible than ever before.

Future ecosystems may also become more specialized and interconnected. Rather than building fully vertically integrated national industries, smaller countries may focus on niche strengths such as:

- component manufacturing
- downstream applications,
- AI and data analytics,
- robotics,
- climate services,
- materials research,
- maritime monitoring,
- education, or
- entrepreneurial incubation.

The growing cislunar economy and long-term expansion of human activities beyond Earth may further increase opportunities for broader international participation. In this environment, ecosystem-building may become not only an economic strategy, but also part of a larger effort to ensure that humanity's future in space is globally inclusive.

This raises important questions for future research, including:

- how ecosystem maturity can be measured,
- how multi-stakeholder coordination evolves over time,
- how ecosystem resilience can be strengthened, and
- how emerging regions can participate equitably in future space economies.

9. Conclusion

The democratization of space is creating unprecedented opportunities for broader global participation in the space economy. However, sustainable ecosystem development does not happen automatically. It requires intentional collaboration, stakeholder alignment, and catalytic leadership.

As demonstrated through the case studies presented in this paper, ecosystems can emerge through multiple pathways - government-led, academia-led, industry-led, or grassroots-driven. Regardless of the starting point, long-term success depends on building strong connections across stakeholders and creating an environment that supports innovation, education, entrepreneurship, and collaboration.

Space enablers play a critical role in this process by convening communities, translating across sectors, initiating activities, and sustaining momentum during the early stages of

development. Their efforts often create the foundational social infrastructure from which more formal institutions and industries later emerge.

Most importantly, the examples discussed demonstrate that meaningful participation in the global space economy is increasingly accessible to regions beyond the traditional space powers. Small initiatives, collaborative networks, and community-driven activities can become the seeds of dynamic and inclusive ecosystems.

Space is for everyone - but ecosystems do not happen by accident.