SINERGI: Journal of Strategic Studies & International Affairs **4, no. 2, December 2024: 50-67.**
10.17576/sinergi.0402.2024.05
eISSN: 2948-4332, ISSN: 2805-4520

TAIWAN'S SPACE FUTURE: THE IMPACT OF TECHNOLOGICAL AUTONOMY AND INTERNATIONAL COOPERATION ©Σ

KUAN YU LIN*

ABSTRACT

This article examines Taiwan's space technology development and its impact on international standing amidst the tension between the national and global approaches. As Taiwan pursues technological independence, it also engages in international cooperation, thus creating a dilemma between political demands and global ethical expectations. Realist theory posits that technological autonomy and national security enhance a country's global status. In contrast, liberalism emphasizes the need for international cooperation and shared technology in space as a collective human interest. The article puts forward two hypotheses: first, increased international cooperation in the space sector raises Taiwan's influence; second, greater technological autonomy may reduce this influence. This study takes "technological autonomy" and "international cooperation" as independent variables, while "international influence" is the dependent variable. This article surveys Taiwan's space technology decisions and their implications for its international position. It indicates that international collaboration is imperative in expanding Taiwan's impact, whereas an emphasis on independence alone may limit its global reach.

Keywords: global influence; international cooperation; national security; space technology; technological autonomy

Σ **Article Info**:

* **First and Corresponding Author**: Kuan Yu Lin, Ph.D. Student (National Chung Hsin University, Taiwan) address: Graduate Institute of International Politics, National Chung Hsin University, Taichung 402. Corresponding Email: 1997lin@gmail.com

SINERGI 4, no. 2 (December) 2024: 50-67.

MASA DEPAN ANGKASA LEPAS TAIWAN: KESAN AUTONOMI TEKNOLOGI DAN KERJASAMA ANTARABANGSA

KUAN YU LIN

ABSTRAK

Artikel ini mengkaji pembangunan teknologi angkasa lepas Taiwan dan kesannya terhadap kedudukan antarabangsa dalam ketegangan antara pendekatan nasional dan global. Ketika Taiwan berusaha mencapai keterbukaan teknologi, ia juga aktif dalam kerjasama antarabangsa, mewujudkan dilema antara tuntutan politik dan jangkaan etika global. Teori realisme menegaskan bahawa autonomi teknologi dan keselamatan negara memperkukuhkan status global sesebuah negara. Sebaliknya, liberalisme menekankan keperluan untuk kerjasama antarabangsa dan perkongsian teknologi angkasa lepas sebagai kepentingan kolektif kemanusiaan. Artikel ini mengemukakan dua hipotesis: pertama, peningkatan kerjasama antarabangsa dalam sektor angkasa lepas meningkatkan pengaruh Taiwan di peringkat global; kedua, penekanan yang berlebihan terhadap autonomi teknologi boleh mengurangkan pengaruh tersebut. Kajian ini mengambil pendekatan bahawa "autonomi teknologi" dan "kerjasama antarabangsa" sebagai pemboleh ubah bebas, manakala "pengaruh antarabangsa" sebagai pemboleh ubah bersandar. Artikel ini meneliti keputusan strategik Taiwan dalam sektor teknologi angkasa lepas dan implikasinya terhadap kedudukan Taiwan di arena antarabangsa. Dapatan kajian menunjukkan bahawa kerjasama antarabangsa adalah penting untuk memperluas pengaruh global Taiwan, manakala penekanan yang berlebihan terhadap keterbukaan teknologi berpotensi mengekang jangkauan globalnya. Kajian ini memaparkan pandangan penting tentang hubungan antara dasar teknologi dan hubungan antarabangsa, dalam dunia yang semakin saling berkait.

Kata kunci: *pengaruh global; kerjasama antarabangsa; keselamatan negara; teknologi angkasa lepas; autonomi teknologi;*

Introduction

Space technology is one of the cornerstones of global strategic competition in the 21st century and links technological progress, national security, economic development, and international prestige (Julienne, 2024). Now, with rapid technological strides and intensifying geopolitical rivalries, the question of dominance in space no longer speaks of a scientific feat; it is more about strategic positioning and innovation. The transformative potential attached to space technology, which ranges from satellite communications and Earth observation to economic leverage in the emerging space economy, makes countries vie for this domain as a better factor in their global influence.

Taiwan is taking active steps to consolidate its position in the aerospace sector (Taiwan Space Agency, n.d.). Driven by the dual imperatives of attaining technological self-sufficiency and establishing strong international cooperation (Julienne, 2024), Taiwan pursues a two-pronged approach towards meeting its twin objectives. Such twin objectives have further underpinned Taiwan's strategic ambition and simultaneously put forth the challenges it faces while trying to position itself in a highly competitive and fast-changing global space industry.

While self-sufficiency for Taiwan seems to mean not having complete dependence on foreign technologies but rather developing resources and skills in priority areas, the Taiwan Space Agency (n.d.) records that investment in local R&D, manufacturing, and talent is all about raising strategic autonomy to the next level and making the economy resilient in a geopolitically rapidly changing world. On the other hand, space technology's inherent difficulty and unaffordability call for international cooperation. Partnerships offer access to advanced technologies, knowledge sharing, and diplomatic opportunities that would otherwise be beyond Taiwan's grasp to keep its place in space globally (Julienne, 2024).

But each of these pursuits contains inherent pitfalls. Self-sufficiency requires huge investments, long-term planning, infrastructure, and talent developed at home. At the same time, international cooperation demands diplomatic acumen, a meeting of interests, and managing geopolitical tensions sans the loss of national priorities. In this context, some inevitable questions arise: How can Taiwan attain self-sufficiency without sacrificing international partnerships? Do both of them lie in mutual exclusiveness, or is there any scope for both of them to coexist in a harmoniously enriching balance?

This paper will try to answer two central questions. First, it attempts to identify approaches that may be taken by Taiwan in order to achieve a proper balance between the conflicting imperatives of "technological self-sufficiency" and "global cooperation." Second, it examines the implications of these approaches for Taiwan's standing within the international community through an analysis of their potential consequences. The study contributes to a nuanced understanding of Taiwan's aspirations in the space sector and its broader implications for its national and global standing by examining these aspects.

SINERGI 4, no. 2 (December) 2024: 50-67.

Theoretical Framework and Point of Conflict

This article discusses a complicated interaction between space technology and international prestige viewed through the prism of the two major theories of foreign relations: realism and liberalism. To that end, this study will discuss the basic precepts of each with a view toward their praxis to make clear not only the theory debates but also the practical implications these frameworks hold for the strategic approach of Taiwan as it develops its space technology. Through this analysis, the study tries to clarify how these views shape Taiwan's efforts to improve its global position and negotiate the intricacies of the fast-evolving space industry.

Fundamental Aspects of Realism and Its Application in Taiwan's Space Technology

Realism, as a basic international relations theory, holds that the international system works in anarchy. In such a framework, states are bound to depend on self-help measures for survival, as no higher authority can offer them security or one that can enforce the rules. Power, defined in terms of military capabilities, economic resources, and technological independence, is seen to be the basis of a state's influence and status in world affairs. For realists, the ability of a state to secure its interests and maintain its sovereignty lies intrinsically in the relative power in that anarchic system (Mearsheimer, 2014).

From this perspective, the independent development of technology becomes one of the most crucial elements of national security. Reliance on foreign resources or external actors comes with risks inherent in such a position, leaving states potentially vulnerable in times of conflict or geopolitical tension.

Nowhere is this principle more salient than in space technology. Capabilities ranging from satellite communications and Earth observation to more advanced defence systems are instruments of scientific progress and powerful symbols of national strength and prestige. The ability to develop and maintain these capabilities independently reflects the state's determination to assert its sovereignty and strategic autonomy. The realist emphasis on self-sufficiency is brought to life for Taiwan in the Formosat program (Julienne, 2024). A very ambitious program, it emphasises the strategic importance of space technology research and development on a domestic level. By emphasising domestic expertise and resources, this program reflects the commitment by Taiwan to lessening its reliance on foreign actors in securing itself amidst rising competition and uncertain international environments. The Formosat satellites, which have been developed to conduct Earth observation and disaster management, served a dual purpose: they contributed to the technological advancement of Taiwan while providing concrete applications to strengthen national security and expedite economic development (Taiwan Space Agency, n.d.).

A realist lens provides a framework to understand how Taiwan might approach space technology in response to the unique geopolitical challenges it has faced. Given its status as a state with limited formal diplomatic recognition and under immense external

pressures, Taiwan's quest for technological autonomy is a strategic necessity rather than just a matter of pride (Julienne, 2024). Developing and deploying such space technologies independently greatly increases the possibility of defending interests, projecting influence, and interacting with the world according to its terms for Taiwan. Formosat proved to be a huge program, and its success testified to the realist principle that 'self-reliance was an important constituent of national power'.

Realism also accepts that there are built-in constraints and trade-offs to self-sufficiency. Taiwan's localised development efforts must be balanced with strategic partnerships to strengthen its autonomy. Cooperation with international actors in the exchange of advanced innovation, knowledge sharing, and joint addressing of challenges that transcend national boundaries is always necessary in the highly interrelated domain of space technology. This tug-of-war between self-reliance and cooperation again evidences the dynamic nature of a realist-inspired approach by Taiwan in space technology (Mearsheimer, 2014).

Fundamental Aspects of Liberalism and Its Application in Taiwan's Space Technology

Liberalism, as the mainstream theory of international relations, represents a view opposed to realism by emphasising the prospect of cooperation within the anarchic international system. First, by realising that there is no effective central authority, liberalism assumes states can reach great cooperation through institutions, common norms, and shared interests. In so doing, multilateralism and technical cooperation are helpful tools to overcome the common challenges ahead and achieve global stability (Keohane & Nye, 1977).

From the UN's perspective, space is conceptualised as a "global commons"—a domain that benefits all of humanity. It hence requires collective governance to preclude monopolistic domination by a few powerful states (United Nations Office for Outer Space Affairs, n.d.). Liberalism underlines the importance of international frameworks, agreements, and cooperation in ensuring fair access to space resources and for safeguarding the long-term sustainability of activities in space. These mechanisms are important for dealing with common issues such as space debris and resource allocation and fostering peaceful cooperation in an otherwise competitive domain.

A more liberalist perspective would bring the strategic benefits of engaging in international cooperation to strengthen its space ambitions (Julienne, 2024). For example, cooperation with NASA and the European Space Agencies has marked how Taiwan has shown its commitment to technology exchange and knowledge sharing. Such partnerships will allow Taiwan to tap into advanced technologies, be a part of leading research, and contribute to joint responses to global challenges like climate change and disaster response. For example, Taiwan's cooperation with Earth observation projects supplies valuable data for environmental monitoring and disaster management, showing the concrete benefits of international cooperation (Taiwan Space Agency, n.d.).

Besides these technological gains, liberalism also emphasised the role of cooperation

in elevating a country's position in the world. By participating actively in joint projects, Taiwan is a responsible and capable actor in the international community (Julienne, 2024). This will not only raise Taiwan's diplomatic visibility but also strengthen its soft power by showing its contribution to global progress. In this sense, Taiwan's collaborative efforts in the space sector are consistent with liberalist principles, which emphasise collective benefits and mutual advancement.

Furthermore, liberalism recognises the interdependence inherent in the modern space industry. No country, no matter how advanced its technological reach may be, can alone tackle the various difficult issues related to space exploration and exploitation. By embracing multilateralism, Taiwan avoids the risks of isolation and builds a network of allies to support its aspirations in the face of geopolitical constraints (Liberty Times Net, 2024). This cooperative strategy reflects the belief in liberalism in the transformative power of shared norms and institutions to create a more inclusive and equitable international system. This liberalist approach also extends to fostering private sector engagement and innovation. Taiwan places itself among the most active participants in the global space economy by creating opportunities for domestic companies to collaborate with their international counterparts (Julienne, 2024). Such partnerships drive technological progress and facilitate Taiwan's integration into international supply chains and research networks, further solidifying its relevance in the global space sector.

Theoretical Comparison: Strengths and Challenges of Either Theory

The different emphases of realism and liberalism in international relations create unique opportunities and challenges for Taiwan's quest for space technology development. Certainly, realism, with its self-reliance focus, parallels the protection of national sovereignty and security of Taiwan. This reduces dependence on foreign technologies, minimising geopolitical risks and maintaining a robust defence posture, as Chari (2009) notes. However, such an emphasis also brings about important challenges. Technological independence requires huge financial resources, long-term investment, and talent development, which is especially burdensome for a small state like Taiwan. In a nutshell, as argued by the Netherlands Office Taipei (2021), over-emphasizing self-reliance at the cost of the absence of cooperation with other states runs the risk of isolating Taiwan from the collaborative benefits of global partnerships in the form of accrued knowledge and state-of-the-art innovations that are essential in a rapidly changing industry.

On the contrary, liberalism relies on multilateralism and international cooperation to achieve more visibility and clout for Taiwan worldwide. Cooperative work may offer access to shared resources, solve problems collectively, and include Taiwan in global space governance for further contribution and soft power development, as deLisle comments (2016). Nevertheless, interdependence is not free of risks either, including dependence on foreign partners, misuse of shared technologies (Phan, 2021), and limited national independence linked to internationally accepted norms and agreements. All these factors have to be weighed with caution to avoid a situation when liberalist politics will result in policies adverse to Taiwan's security and technological goals.

This tension between self-reliance and cooperation calls for a balancing act that can

weigh the strengths of one framework against the weaknesses of the other. Taiwan has to strive toward technological independence to safeguard its sovereignty but must also be choosy in selecting international cooperation in accordance with its strategic interests. Such an approach will have Taiwan retain control over key technologies but realise innovation, visibility, and influence through partnerships with global leaders. By tempering realism, with its strong emphasis on autonomy, with the cooperative values of liberalism, Taiwan can move toward its goals of sustainable space technology development and improvement in its international position.

Table 1. Theotretical Comparison

	Strengths	Challenges
Realism	Protects national sovereignty and security by minimizing dependence on foreign technologies. It ensures greater control over critical infrastructure and reduces external vulnerabilities.	May lead to international isolation by reducing opportunities to collaborate with other nations, potentially limiting access to shared knowledge, resources, and global platforms.
Liberalism	Promotes multilateral cooperation, enhancing international visibility and influence. It also fosters resource sharing, reduces costs, and accelerates innovation through collective efforts.	May weaken national autonomy by requiring alignment with international norms, and exposes the risk of compromising sensitive technological secrets through shared initiatives.

Source: Compiled and Created by authors

SINERGI 4, no. 2 (December) 2024: 50-67.

Research Design and Hypothesis

This article discusses how the balance between technological independence and international cooperation affects Taiwan's status in the global community. It tests two hypotheses: (1) Increased international cooperation enhances Taiwan's global influence; (2) While technological self-reliance strengthens domestic capabilities, a lack of cooperation could diminish Taiwan's global presence. This paper interprets the implications of self-reliance and collaboration through a case study of Taiwan's Formosat Program, offering strategic insights.

The causal relationships between three key variables are analysed:

1. Technological Autonomy (Independent Variable 1): Defined as Taiwan's ability to develop space technology independently, measured by the outcomes of domestic R&D efforts (Fong, 2024).
2. International Cooperation (Independent Variable 2): Measured by Taiwan's participation in joint ventures, partnerships, and treaties (Chen, 2023).
3. International Influence (Dependent Variable): Referring to Taiwan's prestige and authority on the global stage (Wood, 2013).

These interplaying variables determine Taiwan's international status. However, much international cooperation may go a long way in raising exposure and possibilities of engagement; excessive leaning on autonomy unsupported by cooperative efforts is likely to alienate Taiwan and lead to a fall in international standing. For example, technological independence shores Taiwan's domestic foundation but loses the benefit of jointly shared resources and knowledge.

In that light, Taiwan's only remaining task is correctly adjusting its technological independence to structured international cooperation. The dual approach of combining strong technological independence with partnerships would go a long way toward delivering both—a country building an unflinchingly strong and autonomous technical base and using those partnerships to make its voice heard louder in global space governance.

Historical Context of Taiwan's Space Development: From Collaboration to Self-Reliance

The Inception of Taiwan's National Space Program (1991)

In 1991, Taiwan took a major step in its technological development by establishing the National Space Organization (NSPO) and launching the first phase of the National Space Program (Taiwan Space Agency, 2023). This important program marked the beginning of Taiwan's organised efforts to carve a niche in the global space technology arena. This initial phase focused primarily on laying a basic technological foundation, and considerable efforts were directed at building a professional workforce, developing the necessary infrastructure, and creating an innovation environment supportive of space-related R&D activities. This laying of foundations was critical in pursuance of sustainability and competitiveness by Taiwan within this rapidly developing field of space technology (National Applied Research Laboratories, 2023).

The first policy of the Taiwan National Space Program was characterised by a pragmatic orientation towards international cooperation. Recognising the daunting obstacles and heavy resources involved in space research, Taiwan adopted a cooperative approach through partnerships with many of the world's top and most prestigious space organisations (Julienne, 2024). Its strategic alliances formed with NASA in the U.S. and JAXA in Japan helped Taiwan navigate its early steps. These partnerships afforded Taiwanese researchers and engineers critical opportunities to engage with sophisticated technologies, involve themselves in innovative space initiatives, and acquire practical experience in a field that remained in its early stages within the nation (Global Taiwan Institute, 2017) (Julienne, 2024).

Using this approach, Taiwan gained technical expertise and started its installation in the international space tech industry. These collaborations enabled sharing knowledge and best practices, allowing Taiwan to lay a proper foundation for its space program. Moreover, such partnerships helped Taiwan overcome the challenges of breaking into a highly competitive field, building its credibility and reliability in the eyes of international stakeholders (Julienne, 2024).

As time went on, Taiwan's active participation in such initiatives proved its potential as an emerging player in the field of space technology while, at the same time, demonstrating its commitment to advancing the overall objective of international scientific and technological development. The first phase of Taiwan's space program included not only the learning of knowledge and technological development but also the establishment of a strategic vision for future activities. In an act of using international experience coupled with developing its indigenous capability, Taiwan demonstrated a farsightedness now characterising its current policy towards space. The milestones achieved during these early operations laid down foundations that allowed for the development of later achievements and became the way ahead for eventual evolution into one of the significant contributors in the current world space technology arena.

1999: Launch of Formosat-1

The year 1999 marked the year when Taiwan reached another milestone in its venture into space, as it successfully launched its first satellite, Formosat-1. The satellite was built by American Tristar and marked a key landmark for Taiwan's national space program (Gunter's Space Page, n.d.). The fact that Taiwan had outsourced the development but took full control of the operation of ground stations shows its nascent ability to manage and operate satellites technically(Wu, Chen, & Yaung, 2004). This cooperation was the epitome of a strategic partnership, combining Taiwan's aspirations with the technological expertise of the United States, representing the greatest achievement in the technological history of Taiwan (An, 2019).

The first effort at international cooperation in Taiwan's formative years about its space program is characterised by Formosat-1(Wu, Chen, & Yaung, 2004). With powerful backup from the United States through advanced technology and reliable launching service, Taiwan was able to achieve fairly remarkable results in the short term

(An, 2019). Such a leapfrogging strategy not only fast-tracked Taiwan's entry into the highly competitive space technology industry but also provided the learning experience necessary to carve a niche in an arena largely dominated by countries with much bigger existing space programs (Julienne, 2024).

The success of the Formosat-1 mission echoed far beyond the technical realm. It was a resounding affirmation of the fact that Taiwan was ready to take part in the worldwide competition in the field of space technology. The successful deployment and operation of the satellite proved that Taiwan is capable of cooperation on an international scale—skills that will be needed in future projects. It showed the potential of Taiwan to innovate and contribute meaningfully to space-related endeavours and placed it among the serious contenders in this field. This monumental achievement brought quite a few dividends to Taiwan. On the world stage, the successful launch of Formosat-1 significantly raised the prestige of Taiwan as it signalled its commitment to advancing space technology. On the domestic front, this project laid the foundations of the country's national space program and set precedence for future investment in a culture of innovation and being an ambitious aerospace player. It also laid the foundation for expertise and infrastructure that have been important in supporting Taiwan's aspiration in space exploration.

2006: Formosat-3 and Cooperation with the U.S.

The launch of Formosat-3 in 2006 marked the achievement of the space program in Taiwan and continued to symbolize the growing ability of Taiwan to cooperate with the world. Formosat-3 was a global positioning weather satellite system jointly developed by Taiwan and the United States. The launch of this project meant that Taiwan was taking a big stride toward technological sophistication because the satellite's subsystems were produced locally, with the launch made possible by U.S. assistance. Indeed, this joint operation was a fusion of Taiwanese creativity and American know-how, setting a benchmark for future international cooperation (eoPortal, n.d.).

Formosat-3 has been highly successful in upgrading the quality of global meteorological research. The satellite system provided essential meteorological data that most countries had adopted, especially for weather forecasting and climate studies. Its data contributions significantly enhanced the accuracy of weather predictions, making it an asset for researchers and meteorologists worldwide. Taiwan's participation in this project has proven its technical capability and commitment to addressing shared global challenges such as climate change and natural disaster preparedness. The success of Formosat-3 also brought about profound implications for the international standing of Taiwan. With its rise as a major supplier of meteorological data, Taiwan gained recognition and respect within the global scientific community. The resulting visibility has strengthened its position as a reliable partner in international collaborations and increased its influence in the scientific and technological community (*Taipei Times*, 2016).

Formosat-3 showed that the country could combine its technological breakthroughs with the larger goals of the world, placing Taiwan in a very important position in contributing to global space and environmental research. This milestone consolidated

Taiwan's policy of combining self-reliance with international cooperation. While using the ability of domestic forces, Taiwan was actively engaging with its global partners in joint efforts to pursue mutual benefits. It thus kept its space program innovative and internationally relevant (Global Taiwan Institute, 2017). Formosat-3 is a glaring example of how great things can be done through collaboration to make scientific and technological breakthroughs and further consolidate Taiwan's stature as a leader in the global space community.

2017: Formosat-5 — A Symbol of Technological Self-Reliance

The 2017 launch of Formosat-5 marked a milestone in the history of Taiwan's space program, as it was the first time the country had an indigenously designed and built optical remote-sensing satellite. This success symbolized a new era of technological self-reliance and demonstrated Taiwan's independent capability to develop advanced space technologies. Years of investment in research and development were embodied in the launch of Formosat-5, showing the growing expertise and ambition of the scientific and engineering communities in Taiwan (Executive Yuan, R.O.C., 2017).

The pursuit of self-reliance brought with it successes and challenges. Technologically speaking, Formosat-5 represented a huge stride in developing Taiwan's space program, especially in optical remote sensing. That testified to Taiwan's commitment to lessening its reliance on external resources and developing a more independent space program. Still, the satellite's impact on international applications remained relatively modest. Taiwan's developing R&D infrastructure and the limited scope of Formosat-5's capabilities restricted its contributions to the progress of global scientific and technological endeavours (eoPortal, n.d.).

Another challenge was an almost complete lack of foreign participation in the Formosat-5 project. Unlike the vastly more collaborative effort of the Formosat-3 team, which grew into alliances that helped promote Taiwan abroad, Formosat-5 was mainly developed internally within Taiwan (Global Taiwan Institute, 2019a).

While this approach emphasised the nation's self-reliance, it underlined the perils of operating in isolation. Without deeper international partnerships, Taiwan's global engagement and influence waned, and the project missed chances for Taiwan to demonstrate its capability on a world stage and learn from external expertise. Formosat-5 marked a milestone and, at the same time, became a cautionary tale for the development of space in Taiwan. While it underscored the importance of self-reliance for strengthening domestic capability, it also underlined the need to balance international cooperation and technological independence. As Taiwan moves on with its space program, insights from the experience gained through Formosat-5 do, indeed, turn out to be extremely crucial in outlining the gains and limitations connected with such focused self-reliance in a globally interdependent field (Global Taiwan Institute, 2019b).

SINERGI 4, no. 2 (December) 2024: 50-67.

Post-2021: Third Stage of the Space Programme and the Low-Earth Orbit Satellite Venture

Coming to the post-2021 era, Taiwan's National Space Program entered its third stage. In the near future, strategic focuses will be on developing Low-Earth Orbit satellites under this Program. That initiates the change of Taiwan's space ambitions toward fulfilling not just the aspiration to advance technology by self-reliance but also toward the rapidly burgeoning market of satellites. The LEO satellite program aims to integrate state-of-the-art technologies with market-driven solutions in an effort to make Taiwan a strong competitor in the scientific and commercial space arenas (Taipei Times, 2023).

The third phase of the Taiwanese space program reflects the changing character of international cooperation. Well aware of the complexities and interrelation of modern space exploration, Taiwan has tactically teamed up with its European and Japanese counterparts to explore satellite communication technologies (IFRI, 2023).

Such cooperative schemes offer the capability to exchange expertise and facilitate the development of interoperable systems addressing global satellite communication challenges. Finally, in expanding its LEO satellite program toward commercial applications, Taiwan utilises partnerships with multinationals better to match market demand conditions in its space technological development globally (Satellite Markets & Research, 2023). This shift underscores Taiwan's efforts to balance strengthening international cooperation and maintaining a robust foundation of technological self-reliance. In so doing, by integrating domestic innovation with international partnerships, Taiwan enhances its technical capabilities and ensures a diversified approach to achieving its strategic objectives. Such a balanced strategy addresses the dual goals of advancing national technological independence while fostering active participation in the global space community. Since it illustrates a constant effort by Taiwan to rise and tackle the challenges presented by this ever-changing global environment for its space program, particular attention has been placed on LEO satellites post-2021 (Taiwan News, 2023). It reflects how the country adapts its strategies within a fast-advancing field. As Taiwan continues to hone its approach, the LEO satellite project is an important step in solidifying its position as a leader in space technology innovation and a valued contributor to international cooperation.

The Importance of International Cooperation and Risks of Technological Self-Reliance

The Importance of International Cooperation

International cooperation has played a crucial role in Taiwan’s strides in space technology, nurturing innovation, increasing global visibility, and accelerating development. The Formosat-3 project is a prime example of this synergy, illustrating how collaboration with technologically advanced countries such as the United States can produce transformative results. The project, a constellation of six microsatellites for atmospheric and ionospheric research, propelled meteorological science internationally and placed Taiwan in the rank of a credible and reliable

partner within the international space community. It enhanced the scientific reputation of Taiwan and laid the foundations for more in-depth collaborations.

Beyond recognition, cooperation eases the financial and logistical strains of space research and development. Through the sharing of infrastructure, expertise, and resources with global partners, Taiwan has been able to access advanced technologies that would otherwise be too expensive or time-consuming to develop on its own. In this respect, it was underlined by official sources that, because of resource and competency sharing, the cooperation of Taiwan with the US on weather satellite systems—like the FORMOSAT-3 and FORMOSAT-7 programs—substantially reduces development costs. Such a collaborative attitude at once eases the financial burden. It raises the chances of competitiveness for Taiwan within the very dynamic space industry, allowing access to technology and a global position. For instance, equal sharing of funding for the FORMOSAT-7/COSMIC-2 program—Taiwan and the US contributed US$100 million each—has allowed appropriate resource distribution and further innovation (Global Taiwan Institute, 2019c)

Collaboration nurtures innovation through the lively exchange of knowledge and expertise. Taiwan's technical prowess in developing microsatellites and disaster management has placed it in a position of being a substantial contributor to joint projects. At the same time, the insights from its partners expedite its technological advancement. Moreover, participation in global space initiatives offers Taiwan the necessary platforms for diplomatic engagement and the projection of soft power, thus bolstering its identity as a responsible and progressive global player in the face of geopolitical challenges.

Risks of Technological Self-Reliance

While self-reliance brings with it strategic advantages, it also imposes serious challenges—especially when disconnected from international cooperation. In many ways, the Formosat-5 project, the first satellite wholly designed in Taiwan, stands for the promise and constraints of technological independence. While it proved that Taiwan could lessen its dependence on foreign expertise, a lack of international cooperation diminished its global impact. Its applications were mainly confined to domestic purposes, which, in turn, further restricted its contributions to wider scientific advancements and reduced the visibility of Taiwan on the world stage.

Self-reliance also compounds resource constraints. The development of leading-edge space technology independently requires huge financial investments, long periods of time, and a highly skilled workforce—all of which are resources that Taiwan is at a disadvantage compared to global space leaders. For example, Formosat-5 alone took more than NT$5.65 billion—about US$186 million. Without strategic partnerships, Taiwan risks inefficient use of resources and lagging behind modernization in the developing global space industry. That will even out the financial burden through collaboration and drive innovative input with shared expertise (Taipei Times, 2017).

Moreover, isolation constrains Taiwan's ability to navigate technological bottlenecks. Much of the basic improvement in space technology derives from collaborative research, shared infrastructure, and combined intellectual resources. Without diverse opinions, Taiwan may develop blind spots in its innovation strategy, increasing the likelihood of duplication or becoming outmoded. This isolation also weakens Taiwan's geopolitical leverage. Such collaborative projects promote technological development and deepen ties with key global players, offering diplomatic channels to help raise Taiwan's profile in the international community.

SINERGI 4, no. 2 (December) 2024: 50-67.

Theoretical Integration

From a realist perspective, self-reliance strengthens sovereignty and guarantees survival in the competitive global environment; it mitigates risks related to geopolitical pressures coming from foreign technologies and allows full control over vital infrastructure. In turn, liberalism emphasises that international cooperation has mutual benefit through shared innovation and collective governance, placing Taiwan within the global space system. With either approach, security and influence are achievable for Taiwan without overextension and loss of autonomy.

Conclusion: Striking a Balance Between Self-Reliance and Cooperation

The Taiwanese space program epitomizes a critical play of technological self-reliance and international cooperation. Balancing the two approaches in the most competitive field is not strategic but essential for sustainable growth. Self-reliance would mean safeguarding national security and fostering innovation, while international cooperation would accelerate technological progress, extend global influence, and enable access to leading-edge expertise.

The Complementary Nature of Autonomy and Cooperation

Emphasizing self-reliance decreased dependence on foreign technologies, an important concern in times of geopolitical instability. With a deeper reach, solidifying national capabilities ensures resilience and strengthens Taiwan's position in persuading complex international scenarios. For example, Taiwan's Formosat-5 program, the country's first domestically developed satellite, showcases significant advances in autonomous innovation, even if it had to overcome cost and development time challenges. On the other hand, international cooperation opens up unmatched opportunities. Joint projects, such as the Formosat-3 program with the United States, distributed the costs and gave Taiwan global visibility and access to advanced resources. These serve to raise the stature and role of Taiwan within global issues, such as disaster management and climate monitoring, by introducing an active and capable global player.

At this point, the dynamic synergy between self-reliance and cooperation enables Taiwan to connect the dots between local innovation and global collaboration. Building a strong domestic foundation allows Taiwan to better contribute to international partnerships, while the insights acquired through multilateral engagement further enrich its internal R&D endeavors.

Deepening Cooperation & Strengthening Autonomy

To stay ahead, Taiwan needs to work on a two-pronged approach-investing in advanced technologies, including propulsion systems and AI-operated satellites, and cultivating indigenous talents in space sciences while establishing closer relations with the developed powers in space exploration through joint research, jointly conducted launches, and private sector collaboration with SpaceX, ESA, among others. For instance, Taiwan's expertise and experience in disaster management and environmental

monitoring will contribute significantly to the global effort against climate change and prove the country's relevance in finding solutions to the common challenge.

Strengthening its Indigenous R&D ecosystem enables Taiwan to build partnerships from a relative position of strength, so any collaborative initiatives will be configured around attaining its strategic goals over the long run. This approach could diminish the risk of Taiwanese vulnerabilities, reduce dependence on foreign supplies, and lift Taiwan's international standing. Noticeably, Taiwan's manage the development of significant technologies while contributing to global projects places it as both a resilient innovator and a valued global partner

The Harmonious Balance

The future of Taiwan's space program must move toward harmonisation in achieving self-reliance and then strengthening international cooperation. Such a balanced strategy will not only secure Taiwan's national interest but also further extend its influence in the global space community. As space exploration grows in strategic importance, how well Taiwan masters this balance will decide its role in shaping the future of space technology. Combining the strengths of autonomy and cooperation can enable Taiwan to lead progress both for itself and contribute meaningfully to the international community.

Acknowledgement and Declaration

The authors would like to express their gratitude to SINERGI's anonymous reviewers for their constructive feedback, which improved the quality of the manuscript. They are also immensely grateful for their comments on earlier versions of the draft.

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