ARTICLE
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The militarization of space from a Latin American perspective: challenges and strategies

La militarización del espacio en perspectiva latinoamericana: retos y estrategias

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Abstract: Space has become a central axis of geopolitical competition, with powers such as the United States, China, and Russia consolidating advanced space programs in exploration, defense, and telecommunications. While these nations expand their orbital presence, Latin America lacks an integrated regional strategy. This article proposes the application of the Policy Cycle to structure a Latin American Space Policy, promoting cooperation, infrastructure, and technological development. A Latin American Space Plan 2030 is shown, with concrete actions in financing, aerospace education, and regulatory framework. The implementation of this model will reduce technological dependence and strengthen the region's space sovereignty, ensuring its participation in the new global space economy.

Keywords: space policy; astropolitics; regional cooperation; technological sovereignty; aerospace industry.

Resumen: El espacio se ha convertido en un eje central de competencia geopolítica, con potencias como Estados Unidos, China y Rusia consolidando programas espaciales avanzados en exploración, defensa y telecomunicaciones. Mientras estas naciones expanden su presencia orbital, América Latina carece de una estrategia regional integrada. Este artículo propone la aplicación del *Policy Cycle* para estructurar una Política Espacial Latinoamericana, promoviendo cooperación, infraestructura y desarrollo tecnológico. Se presenta un Plan Espacial Latinoamericano 2030, con acciones concretas en financiamiento, educación aeroespacial y regulación normativa. La implementación de este modelo permitirá reducir la dependencia tecnológica y fortalecer la soberanía espacial de la región, garantizando su participación en la nueva economía espacial global.

Palabras clave: política espacial; astropolítica; cooperación regional; soberanía tecnológica; industria aeroespacial.

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1 INTRODUCTION

The twenty-first century has witnessed accelerated progress in the exploration and exploitation of space. Powers such as the United States, China, Russia, and the European Union have established space programs with advanced capabilities in launchers, satellites, planetary exploration, and orbital defense (Moltz, 2019; Samson; Cesari, 2022). The recent competition for control of space is not only driven by scientific and commercial interests, but also by a growing interest in the security and strategic dominance of Earth orbits and celestial bodies (Golia, 2025).

The United States, via its Space Force, has strengthened the protection of its satellite assets and has developed new technologies to control orbital traffic (United States, 2020). China has consolidated its space program with the construction of its Tiangong station, with missions to the Moon and Mars, and the deployment of the BeiDou satellite network as an alternative to GPS (People's Republic of China, 2019). Russia maintains a strong presence with its satellite systems and interception technologies in space, while the European Union has opted for advanced telecommunications projects and scientific missions to asteroids and other celestial bodies (ESA, 2022).

Faced with this global dynamic, Latin America has not been able to develop a coordinated space program. Despite national efforts such as Brazil's Space Program (AEB, 2012), Argentina's SAOCOM mission (Conae, 2020) or PeruSAT-1 (Conida, 2017), the region lacks a unified strategy to consolidate its presence in space. From this perspective, the Latin American and Caribbean Space Agency (ALCE) was announced in October 2020, when Mexico and Argentina signed an agreement for its creation under the auspices of the Community of Latin American and Caribbean States (CELAC). This initiative represents a key effort for regional integration in the aerospace field, promoting technological and scientific cooperation between the countries of Latin America and the Caribbean. However, its consolidation faces significant challenges, such as the lack of ratification by several States, the asymmetry in space capabilities, and the need for sustained financing (Sandoval, 2024). Without a common policy, Latin American countries run the risk of perpetuating their dependence on foreign suppliers for critical services such as telecommunications, environmental monitoring and satellite security, as warned by studies on the region's space capabilities and on the creation of the ALCE (Jakhu; Pelton, 2017; Sandoval, 2024; UNOOSA, 2024; UCS ..., 2005).

In addition to these national efforts, the region already has experience of bilateral cooperation that illustrates the potential for deeper integration in the space domain. An emblematic example is the SABIA-Mar (Argentine-Brazilian Satellites for Environmental Information of the Sea) mission, conceived as a joint Earth observation constellation focused on the study of the ocean biosphere, the carbon cycle, and coastal ecosystems (Conae, 2020; UNOOSA, 2024). In this project, Argentina and Brazil share technical and industrial responsibilities in the design, construction, and operation of the satellites, by the articulation of their space agencies and industrial capacities around common scientific objectives. This experience shows that regional space integration, understood as the sustained coordination of resources, infrastructures, and human capital to develop and exploit shared space systems, is not only possible, but offers a concrete precedent for the type of cooperation that could be expanded and formalized under the ALCE umbrella.

Recently, the traditional logic of geopolitics, focused on the control of territories, maritime routes and material resources, has been progressively complemented by the notion of **Astropolitics**, which places outer space at the centre of strategic competition. From this perspective, constellations of communications, navigation, and Earth observation satellites become critical infrastructures for multi-domain security, the digital economy and the management of natural resources, so that sovereign access to space orbits, frequencies, and capabilities becomes a determinant of power (Bowen, 2020; Dolman, 2002; Johnson-Freese, 2007).

For Latin America, this transition from geopolitics to astropolitics implies that the formulation of its own space policy is no longer a technological luxury but a requirement for strategic autonomy. Without a common vision, the countries of the region run the risk of remaining dependent users of space services provided by external powers, with limited capacity to influence the rules of the game that structure the new space order.

This scenario is part of what various analysts call the **Second Space Age**, characterized by the combination of a growing militarization of space dominance, the entry of new state actors, and the expansion of the **New Space Economy**, where commercial constellations, low-orbit platforms and data services from space make up a veritable **Orbital Economy** (Harrison *et al*., 2017; Peeters, 2025; The space ..., 2023). At the same time, concepts such as "**cislunar security"** and the "**awareness of the spatial domain" (***Space Domain Awareness***)**, which underline that satellites and orbits are not only critical infrastructure for development, but also potential scenarios for "gray zone" operations by space powers (Parr; Rainey, 2022; SIPRI, 2024; USSF, 2023).

Against this backdrop, this article proposes the application of the *Policy Cycle* as a key tool for structuring a Latin American Space Policy, ensuring the integration of national capacities, the optimization of resources, and long-term sustainability (Howlett; Ramesh; Perl, 2009; Jann; Wegrich, 2007; Del Canto Viterale, 2024). The implementation of a Latin American Space Plan 2030 will enable the region to advance in the construction of space infrastructures, the development of its own satellites, the formation of human capital, and the promotion of a competitive aerospace industry.

2 THEORETICAL REVIEW

2.1 Space as a fifth domain of warfare

The conception of outer space as a new field of confrontation has been consolidated in recent years, so that it is considered the fifth domain of warfare after land, sea, air and cyberspace (Golia, 2025; Sheehan, 2007). This approach arises from the strategic importance that communications, navigation, observation, and intelligence satellites have acquired, as well as from the development of technologies capable of interfering with or destroying these orbital assets (Samson; Cesari, 2022).

Historically, war was limited to land and sea, which were the scenes of imperial and colonial conflicts. Subsequently, the invention of military aviation in World War I inaugurated the air as the third domain. The digitization of information and telecommunications gave way to cyberspace as the fourth domain, in which defense and attack are conducted via computer systems (Moltz, 2019).

Recently, outer space has been added to this list by becoming a critical factor for the military operations of the powers, as satellites enable the synchronization of troops, missile guidance, and the obtaining of intelligence in real time (Golia, 2025).

According to Nettis (2020), the integration of warfare domains (space, air, electromagnetic spectrum, land, and sea) with key cross-cutting sectors such as space technology, cybersecurity, intelligence, and electronic operations is at the core of the so-called Multi-Domain Operations (MDO), which aims to synchronize forces on different fronts via agile command and control systems to exploit adversary vulnerabilities at all levels. Following the concept of MDO, this strategy seeks to synchronize forces on different fronts via agile command and control systems, breaking enemy cohesion and exploiting vulnerabilities at all levels.

Interoperability between institutions and strategic sectors has become relevant in the context of security and defense, which allows for better integration of capabilities and optimization of resources in multi-domain scenarios. According to Bolaños Ramírez, Jiménez Vélez, and Noboa González (2022), the ability of States to operate jointly in strategic environments depends on their capacity for coordination, standardization of processes, and effective information exchange. In the aerospace field, these principles can be transferred to cooperation among Latin American countries, promoting synergies in satellite development, space exploration and orbital security. In this way, interoperability not only improves the response to global threats, but also strengthens the region's technological sovereignty and reduces dependence on external actors (Bolaños Ramírez; Jiménez Vélez; Noboa González, 2022).

2.2 UN Space Laws, Regulations and Standards

International legislation on space activities is based on a set of treaties and conventions established mainly under the auspices of the United Nations (UN). These agreements, although mostly dating from the second half of the twentieth century, still constitute the central regulatory framework for the use and exploration of outer space. Table 1 details some of the main instruments.

Table 1 – Space regulations

Name of Law/Treaty	Year	Subject
Outer Space Treaty (*Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*)	1967	It prohibits the national appropriation of space and the placement of nuclear weapons in orbit. It provides for the peaceful use of space for the benefit of humanity and holds States accountable for the activities of their public and private entities.
Astronaut Rescue Agreement (*Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*)	1968	It requires assistance and rescue to astronauts who land unexpectedly in another territory, as well as to return fallen space objects outside their launch site.

Name of Law/Treaty	Year	Subject
Convention on International Liability for Damage Caused by Space Objects (*Convention on International Liability for Damage Caused by Space Objects*)	1972	It establishes the responsibility of a State for damage caused by its space objects. On Earth or aircraft in flight, the responsibility is absolute; In space, liability for fault applies.
Convention on Registration of Objects Launched into Outer Space (*Convention on Registration of Objects Launched into Outer Space*)	1975	It obliges States to register their space objects both in a national registry and with the UN to improve the transparency and location of the devices in orbit.
Agreement Regulating the Activities of States on the Moon and Other Celestial Bodies (*Moon Agreement*)	1979	It declares the Moon and other celestial bodies as the common heritage of humanity. It proposes an international management regime and prohibits its appropriation. Its adherence is limited, as the major space powers have not ratified it.

Source: Own elaboration (2025).

In the case of Latin America, this regulatory framework poses both opportunities and restrictions. On the one hand, UN treaties provide a common legal basis – particularly the 1967 Outer Space Treaty and the 1972 Liability Convention – on which a regional agency such as the ALCE could coordinate object registration, orbit assignment, and risk management, thereby reducing transaction costs and avoiding regulatory duplication (Treaty ..., 1966; Del Canto Viterale, 2024).

On the other hand, the absence of up-to-date agreements on resource exploitation, space debris mitigation, and the proliferation of anti-satellite technologies makes it difficult for States in the region to define convergent positions in multilateral forums, which may limit the effectiveness of a truly integrated Latin American space policy (Simberg, 2012; Jakhu; Pelton, 2017).

2.3 Global Players: Key Milestones and Public Policies for Space Leadership

While the current international legal regime obliges States to limit the appropriation of space and encourages its peaceful use, three powers stand out in shaping a new space race for strategic and military purposes: The United States, Russia, and China. Table 2 describes that each country has established public policies and specific organizations to lead in this area, with historical milestones that have defined their role as "global protagonists".

Table 2 – Leading countries in the space field

Country	Key Milestones	Main Policies
United States	• NASA (1958) and the Apollo Program (1969 moon landing) • Space Shuttle (1981) • International Space Station (1998) • Space Force (2019)	• National Aeronautics and Space Act (1958) • Commercial Space Launch Act (1984) • Space Policy Directives (2017-2020) • Defense Space Strategy (2020)

Country	Key Milestones	Main Policies
Russia	• Sputnik (1957) • First human being (Gagarin, 1961) • MIR Station (1986-2001) • Soyuz/Progress (in force since the USSR)	• Creation of Roscosmos (1992) • Russian Military Doctrine (2014) • Military modernization (2011-2020) • ERA Cooperation, GLONASS
China	• ASAT Test (2007) • Shenzhou Program (since 1999) • Tiangong Station • Chang'e Mission (lunar exploration)	• Strategic Support Force (2015) • Defence White Paper (2019) • Five-year plans (exploration and exploitation of resources) • Cooperation (Russia, Europe)

Source: Own elaboration (2025).

2.4 Cooperation dynamics *vs.* Competition

Interstate interaction in the space domain combines, on the one hand, scientific and commercial collaboration – exemplified by projects such as the International Space Station – and, on the other, strategic rivalry driven by the development of anti-satellite weapons (ASAT) and the creation of space forces, stemming from the critical importance of satellites for communications and intelligence (Moltz, 2019; Golia, 2025; Sheehan, 2007). This tension is reinforced by the dual nature of orbital technology, which makes it difficult to clearly distinguish civilian and military uses (Vera *et al*., 2023). Although UN treaties emphasize a peaceful use of space, the lack of regulatory updating has enabled the increase in tests that generate debris in orbit or the justification of offensive capabilities under the label of "experimental missions" (Samson; Cesari, 2022). From a realistic perspective, States prioritize the protection of their assets and technological supremacy in the absence of a supranational authority with coercive power (Sheehan, 2007; Waltz, 1979). Although non-aggression and transparency mechanisms are discussed in forums such as the Committee on the Peaceful Uses of Outer Space (COPUOS) and the Conference on Disarmament, progress is limited, in part due to the reluctance of powers to cede their freedom of action (Moltz, 2019). In view of this, several authors recommend promoting science diplomacy and international cooperation to prevent this "new space race" from leading to confrontations on a global scale (Vera *et al*., 2023). In this context, the way in which peripheral regions construct their own cooperation mechanisms acquires strategic importance.

In the field of knowledge and science diplomacy, particularly in Latin America, this search for cooperative spaces is manifested in initiatives that can serve as a basis for a more articulated regional space policy. The Latin American and Caribbean Space Network (ReLaCa Espacio) brings together universities and institutions that research in outer space technology, policy, and law, organizing periodic international meetings, such as those held in Jaén in 2024 and in Bogotá in 2025, to discuss regulation, security, commercialization and development of the space sector (Encuentro ..., 2025). These academic networks contribute to the formation of a regional epistemic community that shares diagnoses and conceptual frameworks and can become a key actor in technically supporting the ALCE agenda and legitimizing, from the scientific field, greater Latin American spatial integration, gradually tipping the balance of the dynamics of competition towards more cooperative models of governance of outer space.

2.5 Implications for the foreign policy of states

Space has acquired such strategic and economic relevance that foreign policies can no longer be restricted to the land, sea, air, or cyber dimensions, which requires combining multilateral diplomacy, scientific-technical cooperation, and attention to geopolitical competition (Bowen, 2020; Freedman, 2017). In this area, space diplomacy has become a resource of soft power, since participating in global initiatives such as the International Space Station or joint missions strengthens the image of modernity and cooperation of States, while promoting transparency and reducing tensions between historical adversaries (Johnson-Freese, 2007; Pelton, 2015). However, the high cost of access to orbit and the technical complexity of the environment have an impact on the construction of alliances and regional blocks such as the European Space Agency (ESA) or the ALCE, which share infrastructure and knowledge, although friction arises when the powers offer cooperation subject to political interests (Hertzfeld, 2018). Moreover, the development of a solid space sector can constitute a symbol of prestige and internal modernity, which reinforces the legitimacy of governments and articulating foreign policy with objectives of technological innovation and STEM (Science, Technology, Engineering, and Mathematics) education (Bowen, 2020; Freedman, 2017; Johnson-Freese, 2007).

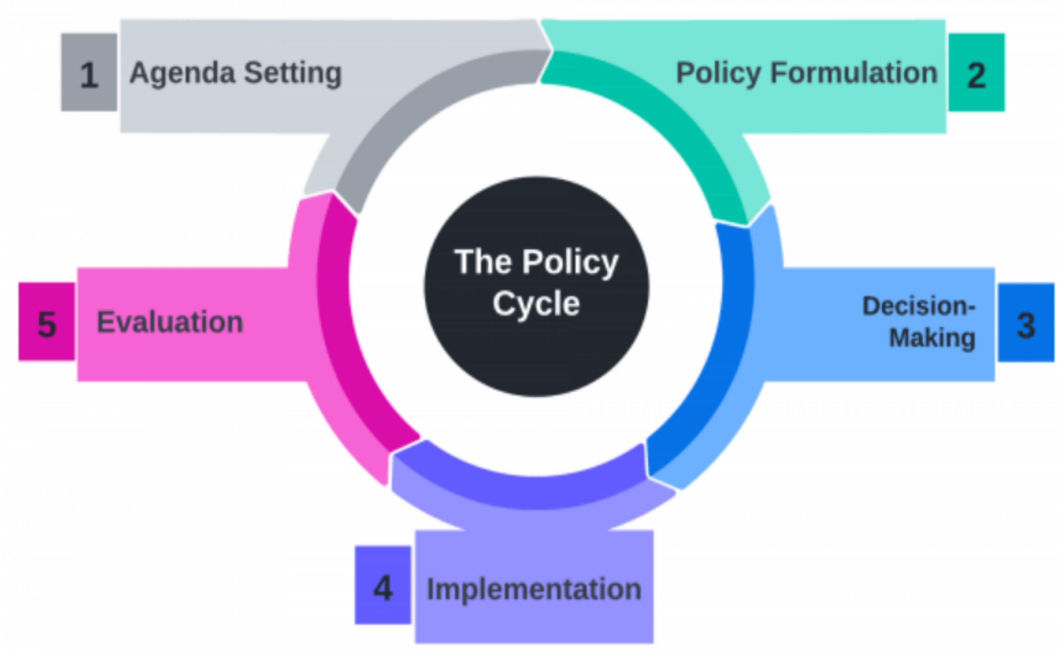
2.6 Space resources and economic competition

Space activity, previously limited to scientific exploration, has become an emerging market with prospects of high economic value, reflected in asteroid mining initiatives and the development of mega-constellations of satellites (Jakhu; Pelton, 2017; Space ..., 2020). Companies such as SpaceX, Blue Origin, and Virgin Galactic are leading innovation and cost reduction, while governments and private companies investigate the feasibility of extracting valuable resources from the Moon or asteroids (Elvis; Milligan, 2019; Gréková, 2017). However, the absence of an updated legal framework leads to fears of a space "gold rush," with possible disputes over areas of exclusivity and property rights (Simberg, 2012). Consequently, international cooperation, which is essential for large-scale projects, seeks to avoid the militarization of resource extraction and to maintain space as a common good (Treaty ..., 1966).

2.7 The *Policy Cycle* as a Model for the Implementation of Public Policies

The *Policy Cycle* is a theoretical model that organizes policy formulation, implementation, and evaluation in sequential stages (Figure 1), providing structured guidance for detecting problems, designing solutions, allocating resources, and adjusting strategies as political, economic, or social conditions change (Howlett, Ramesh; Perl, 2009; Jann; Wegrich, 2007; Sabatier; Jenkins-Smith, 1993). In practice, governments first define the public agenda, then formulate policy options, adopt them through laws or programs, implement them in coordination with state and private actors, and, finally, measure the results to provide feedback on the process. The applicability in the space field is demonstrated in initiatives such as Copernicus and Galileo led by ESA, and it is shown as a viable tool to structure cooperation and sustainability of space projects in Latin America (Del Canto Viterale, 2024).

Figure 1 – ***Policy Cycle***



Source: University of Auckland (Perspectives ..., 2022).

3 METHODOLOGY

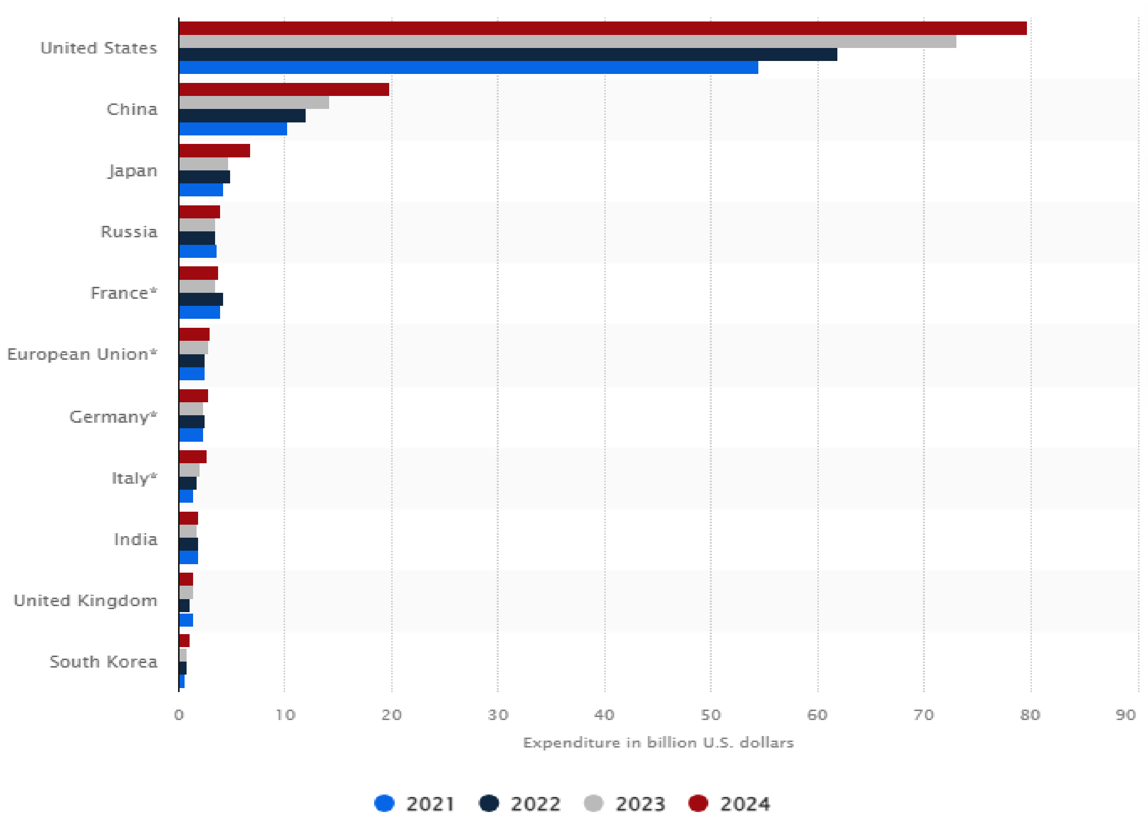
A qualitative approach of a descriptive and exploratory nature was applied, based on the analysis of secondary sources to understand the militarization of space, its impact in Latin America and possible reinforcement strategies in the region. This was followed by a review of official documents and declarations (national plans and regional regulations) to clarify the approach to space governance in Latin American countries. Finally, a comparative analysis of satellite capabilities and regulatory frameworks was conducted, triangulating information from international organizations, national agencies, and academic literature, aiming to provide a comprehensive and contextualized perspective on the trends and challenges of space militarization in the region.

4 RESULTADOS

4.1 Statistical Analysis

Figure 2 shows a sustained evolution in government spending on space programs between 2021 and 2024, totaling more than $130 billion. The United States leads the ranking with nearly $80 billion invested in 2024, well above the other powers. China is the second largest player with around 19 billion, followed by Japan, Russia, and several European countries whose investments are below 10 billion.

Figure 2 – Government spending by country

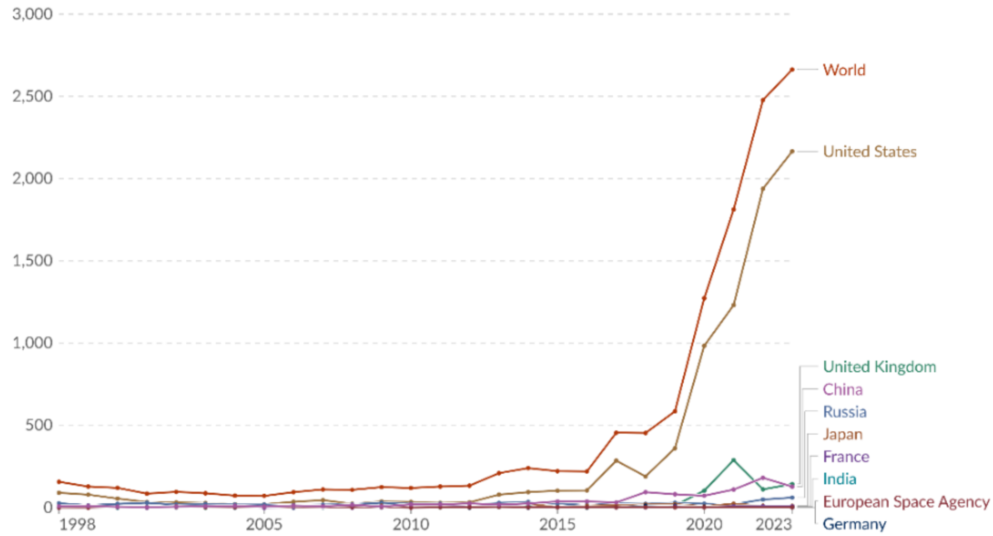


Source: Statista (2025).

These data are in line with what has been reviewed in the literature on the militarization of space and the consolidation of space forces. The strong budget increase in the United States is not only explained by NASA's civilian budget estimated at $27.2 billion by 2024, but also by Defense allocations for security and technological development projects (Novaspace, 2025). Similarly, China, Russia, and other powers have stepped up their investment, largely to bolster observation capabilities, secure communication and potential anti-satellite systems. Thus, the gap in spending reflects not only scientific or commercial interests, but also the growing importance of defense and strategic position in orbit.

Figure 3 of UNOOSA (2024) details the annual evolution of the number of space objects launched into Earth orbit or beyond (satellites, probes, manned spacecraft, etc.). Such objects are attributed to the country or organization that funds them, not necessarily to the place of launch. From 2015 onwards, the global number of launches increased significantly, exceeding 2,000 objects per year. This increase is related to the rise of satellite constellations (mainly from private companies), cost reductions and the development of smaller satellites. The United States leads this growth due to the proliferation of large constellations (*e.g.*, Starlink). China and other countries also show increases, although less marked.

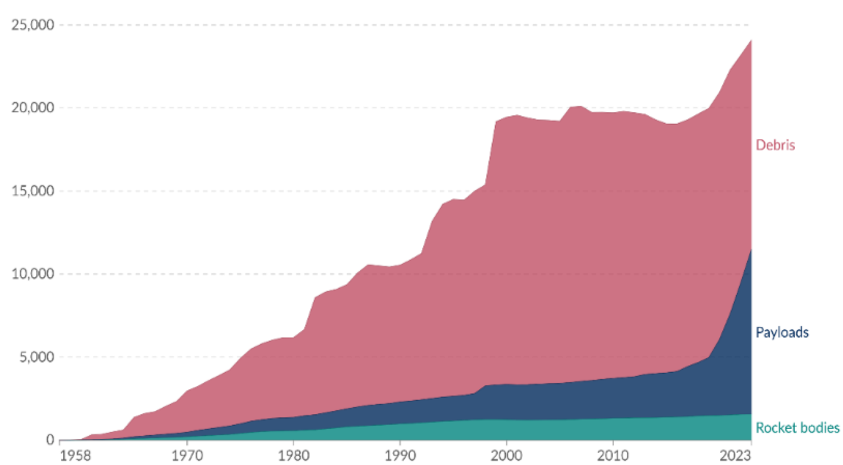
Figure 3 – Number of space objects launched into Earth orbit



Source: UNOOSA (2024).

Figure 4, published with data from the United States Space Force (USSF, 2024), presents the number of objects detected in low-Earth orbit (below 2,000 kilometers in altitude) according to their type: satellites (*payloads*), rocket stages (*rocket bodies*) and space debris (*Debris*). A continuous increase is observed from the 1960s to the present, with a significant increase in debris (or fragments) from the end of the twentieth century. Although the graph is limited to tracked objects (large enough to be tracked), ESA estimates the existence of more than 130 million fragments of space debris larger than 1 millimetre. Note that objects are subtracted from the graph when they re-enter the atmosphere and disintegrate. This growth reflects the cumulative impact of decades of launches, tests, and fragmentation events, coupled with a recent increase in commercial and government space activity.

Figure 4 – Number of objects detected in low-Earth orbit



Source: United States Space Force (2024).

Figure 5 shown by the CSIS Aerospace Security Project (2022) shows NASA's annual budget from 1959 to 2022. A large increase is observed in the 1960s during the space race and the Apollo program, followed by a sharp decline after humans landed on the Moon. Over the years, the budget has fluctuated based on new initiatives (e.g., the Space Shuttle and the International Space Station), showing a moderate growth trend over the past decade.

Figure 5 – NASA Annual Budget

Source: CSIS Aerospace Security Project (2022).

The main satellite capabilities in the region are shown below (Table 3), along with the participation of the private sector, aerospace education, public policies, and the challenges that militarization brings to each Latin American nation. The satellite data are based on the UCS Satellite Database (UCS ..., 2005), supplemented by information from national agencies and academic publications.

Table 3 – Analysis of Latin American countries in the space field

Country	Satellites & Features	Private Sector	Aerospace Education	Public Policies
Brazil	No. and uses: ~6 satellites (e.g. Amazonia-1 for observation and CBERS with China). Earth observation, telecommunications and meteorology (AEB, 2012).	Visiona (Embraer-Telebras joint venture) manufactures telecommunications satellites (AEB, 2012).	ITA and Universidade de Brasília offer aerospace engineering (AEB, 2012).	PNAE: Goals in R&D and defense (AEB, 2012). MCTI funds space projects. Ministry of Defense (FAB) protects space infrastructure (Brazil, 2018). PESE, a strategic document that integrates civilian and military objectives.

Country	Satellites & Features	Private Sector	Aerospace Education	Public Policies
Argentina	No. and uses: ~6 satellites (SAOCOM 1A/1B for observation, ARSAT-1/2 for telecommunications). It includes scientific missions such as SAC-D/Aquarius (Conae, 2020).	Invap (state-mixed) and Satellogic (observation microsatellites) lead the construction and commercialization of satellite (Conae, 2020).	UBA, UTN, UNLP: aerospace and electronic engineering (Conae, 2020).	National Space Plan 2021-2030 (Conae, 2020). Ministry of Science, Technology and Innovation articulates R+D (Law 27.208).
Mexico	No. and uses: ~4 satellites (MEXSAT Morelos 3 and Bicentenario for communications, Eutelsat 113 West A). Small university cubesats in experimentation (AEM, 2019).	ThrustSpace and Space JLTZ: rockets and picosatellites. SATMEX (now Eutelsat) with relevance in TV and data (AEM, 2019).	UNAM and IPN: programs in aerospace and mechanical engineering (AEM, 2019).	Space Activities Programme 2019–2030 (AEM, 2019). CONACYT finances aerospace research projects. SEDENA and SEMAR use satellite imagery for security.
Chile	No. and use: 1-2 satellites (FASat-Charlie for observation, cubesats SUCHAI I-III). Civil and security functions, university research (Proyecto ..., 2020).	Image processing and drone startups (Sources; Flores, 2017). Coordination with the FACh on dual technologies.	Univ. of Concepción and UTFSM: nanosatellites and propulsion. SUCHAI Project (Univ. of Chile): university satellites.	No consolidated space agency: the policy is coordinated via the Council of Ministers for Space Development (Decree 172/2015). FACh manages FASat. Ministry of Science (2018) promotes R+D projects.
Colombia	No. and use: Without a large constellation of its own; only experimental cubesats such as Libertad 1 (U. Sergio Arboleda). It does not have permanent geostationary satellites or observation (Ramírez, 2021; UCS ..., 2005).	SMEs in geospace software and consulting, incipient ecosystem (Ramírez, 2021). Lease of satellite capacity to foreign powers.	U. Sergio Arboleda, U. National and U. of Antioquia: research in nanosatellites, robotics (Ramírez, 2021).	No official space agency or integrated plan; scattered initiatives in the Ministry of Science and Defense (Law 1286/2009; Decree 2226/2019). Proposals for a council/agency to centralize space policy (Ramírez, 2021).
Peru	PerúSAT-1 (2016), intended for resource observation and security purposes (CONIDA, 2017). Small university satellites, such as PUCP-Sat.	Several companies are involved in the integration of communication systems and image analysis. Cooperation with France for the maintenance of PerúSAT-1 (CONIDA, 2017).	UNI and PUCP: robotics, microsatellites, and propulsion (CONIDA, 2017).	CONIDA, linked to the Ministry of Defense, leads space policy and operates PerúSAT-1 (Law 27699). CONCYTEC funds aerospace R&D with limited resources.

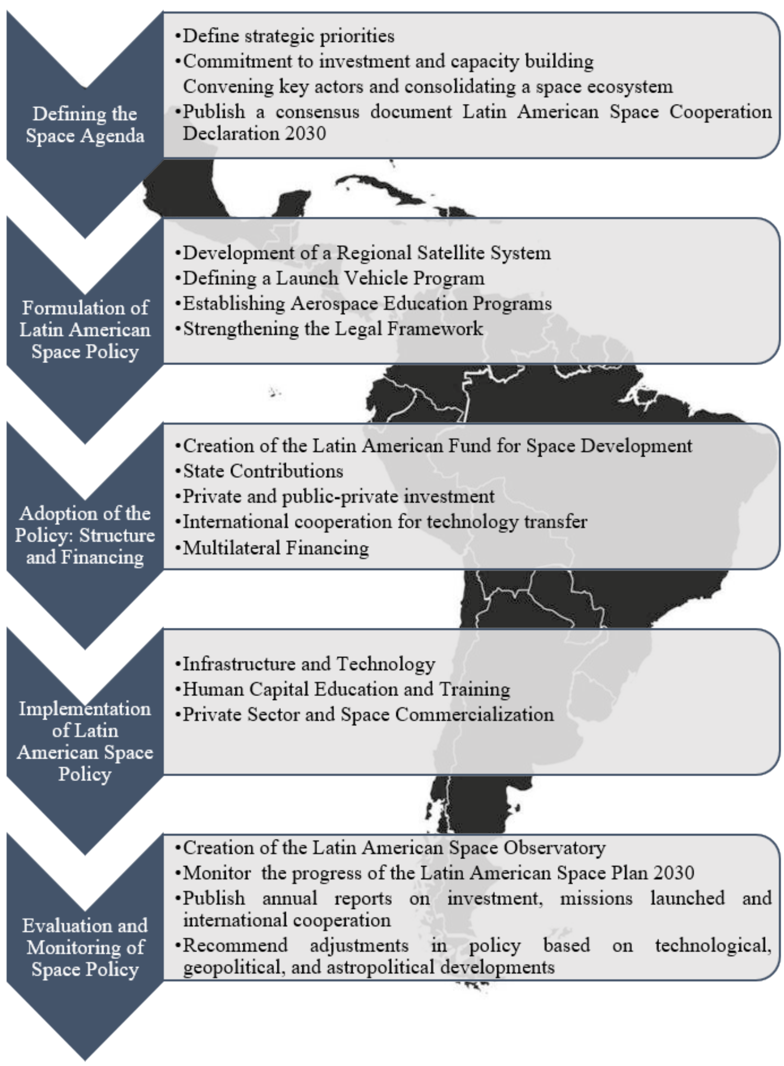
Source: Own elaboration (2025).

The list of private companies listed in Table 3 is illustrative and not exhaustive. Only a few representative actors in each country are included, based on the information available in the sources consulted.

4.2 Proposal for the Implementation of the *Policy Cycle* in Latin American Space Policy

In this context, the *Policy Cycle* it is shown as an ideal model (Figure 6) to guide the formulation and consolidation of a Latin American space program, ensuring that each stage of the process is addressed with clarity and precision. The diagram below summarizes the proposed strategy by dividing the process into five key phases.

Figure 6 – Space Policy by *Policy Cycle*



Source: Authors, adapted from University of Auckland (Perspectives ..., 2022).

4.3 Identification of the Problem and Definition of the Latin American Space Agenda

For Latin America to consolidate an effective space policy, it is necessary to establish a clear strategic agenda, identifying needs, opportunities and key actors. This stage makes it possible to lay the foundations for a solid and sustainable cooperation over time.

4.3.1 Defining strategic priorities

These priorities reflect emerging consensuses in the space governance literature, which underscore the centrality of telecommunications, Earth observation, and disaster risk management as pillars of national space policies (Bowen, 2020; Jakhu; Pelton, 2017; UNOOSA, 2024).

- **Telecommunications:** Reduce dependence on foreign satellite infrastructure by developing its own communication satellites.
- **Earth observation:** Implement a network of satellites for monitoring natural resources, climate change, natural disasters, and food security.
- **Defense and security:** Develop satellite surveillance capabilities for national security and air and maritime traffic control.
- **Space exploration:** Initiate research programs in microgravity, cooperation with space stations, and missions to the Moon and Mars in collaboration with international agencies.

4.3.2 Commit States to invest in and develop their own space capabilities

The setting of minimum budget targets and the creation of regional funds for innovation have been recommended in various studies on space cooperation and capacity building in developing countries as mechanisms to overcome fragmentation and achieve economies of scale (Gréková, 2017; Jakhu; Pelton, 2017; Del Canto Viterale, 2024). Among them, we highlight:

- Setting a percentage of each member country's GDP to finance the ALCE;
- Create a Regional Space Innovation Fund, financed by multilateral organizations such as the Inter-American Development Bank (IDB) and CAF;
- Include space policy in national development plans, ensuring its continuity beyond changes of government.

4.3.3 Convening key actors to consolidate a space ecosystem

The systematic incorporation of universities, research centers, and start-ups is aligned with the recommendations of the literature on "new space", which emphasizes the need for open and collaborative innovation ecosystems to energize the space economy (Gréková, 2017; Space ..., 2020). Each key actor seeks to meet some objectives within its within its scope.

- **Universities and research centres:** Develop academic programs in aerospace engineering, space science, and telecommunications;
- **Private sector:** Encourage investment by technology companies and startups in satellite projects, rocketry, and space *Software*;
- **International space agencies:** Foster cooperation with NASA, ESA, CNSA (China), Roscosmos and JAXA for technology transfer and talent training.

4.3.4 Publish a consensus document entitled Declaration of Latin American Space Cooperation 2030

- Formal agreement among the countries of the region to establish a unified space program.
- Commitment by governments to invest and coordinate efforts in the development of space infrastructure.
- Regional integration strategy through ALCE to avoid fragmentation of efforts and maximize resources.

4.4 Formulation of Latin American Space Policy

In this phase, a Latin American Space Plan 2030, which will define the objectives and strategies for the development of space capabilities in the region.

4.4.1 Development of a Regional Satellite System

- Implementation of **a constellation of regional satellites** for telecommunications, remote sensing and environmental monitoring;
- **Telecommunications:** Creation of geostationary satellites to guarantee access to the internet and secure communications in rural and remote areas;
- **Environmental monitoring:** Use of satellites for earth observation, deforestation monitoring, forest fire detection and climate change monitoring;
- **Security and defense:** Implementation of satellites for maritime surveillance, detection of illegal activities and response to natural disasters;
- Creation of **a satellite data processing and analysis center** that enables efficient management of the information obtained.

4.4.2 Definition of a Launch Vehicle Program

Brazil and Argentina to lead development of rockets and space launchers, drawing on its experience in projects such as the VLS (Satellite Launch Vehicle) and Tronador II. In this program it is essential to:

- Implement a Regional Spaceport in Alcântara, Brazil, due to its equatorial location that reduces launch costs;

- Incentivize investment in Reusable rocketry and more efficient propulsion technologies;
- Create a Public-private consortium to develop and operate launchers for commercial and scientific missions.

4.4.3 Establishment of aerospace education programmes

In this area, the following items are important:

- Creating a Latin American Aerospace Education Network, with programs in aerospace engineering, astrophysics, and space telecommunications;
- International Scholarships and Internships for the training of scientists and engineers in agencies such as NASA, ESA, CNSA and Roscosmos;
- Incorporation of Training for technicians and engineers in the manufacture of satellites, rockets and ground stations;
- Implementation of Nanosatellite Simulation and Manufacturing Laboratories in universities and research centers.

4.4.4 Strengthening the legal framework

In this matter, it is necessary to take into consideration:

- Drafting of a Regional Framework Law on Space Policy, which standardizes regulations in all countries of the region;
- Creating a Regional Satellite Registry, in which the rights to operate and use orbits are managed;
- Establishment of a Regulatory Framework for Private Investment, enabling technology companies to participate in space projects;
- Implementation of Space Debris Management Standards, promoting sustainability practices in the aerospace sector.

4.5 Adoption of the Policy: Institutional Structure and Financing

To guarantee the sustainability and viability of Latin American space policy, it is essential to establish a clear institutional structure and a stable financing mechanism.

4.5.1 Creation of a Latin American Space Development Fund

- Administered by the ALCE to finance joint projects;
- Will be used for the development of satellites, launch vehicles, infrastructure and aerospace education programs;
- Its allocation of resources will be overseen by a technical committee composed of representatives of member countries, academic experts and private sector actors.

4.5.2 State contributions: Direct contribution from member countries

- Each nation shall allocate a minimum percentage of its annual GDP to the ALCE to ensure the continuity of space programmes;
- The inclusion of space policy in National Development Plans to avoid discontinuity with changes of government;
- An equitable redistribution mechanism, in which countries with less economic capacity can receive financial support to develop their space capabilities.

4.5.3 Private and public-private investment

- Creation of tax incentives to attract investment from Startups and aerospace companies in areas such as satellite, rocket and Software navigation;
- Development of Space Economic Zones in Brazil and Argentina, where companies can set up with tax benefits;
- Promotion of public-private partnerships with large technological corporations for the manufacture and operation of satellites;
- Establishment of venture capital funds to support innovative ventures in the space sector.

4.5.4 International cooperation for technology transfer

- Signature of strategic agreements with space agencies such as NASA, ESA, CNSA (China) and Roscosmos (Russia) for knowledge transfer;
- Inclusion of Latin America in International space missions, participating in lunar exploration projects and missions to Mars;
- Development of exchange and training programs in aerospace engineering and space sciences with universities and research centers from leading countries in the sector.

4.5.5 Multilateral Financing

- Presentation of the Latin American Space Plan 2030 in the face of organizations such as the IDB and the Development Bank of Latin America to receive funding and technical assistance;
- Inclusion of the space sector in the investment programmes of the UN, OECD and World Bank, highlighting its impact on telecommunications, the environment and security;
- Creating a Space bond-based financing mechanism, where investors can contribute to space projects with financial incentives and return on investment in satellite technology and telecommunications.

4.6 Implementation of Latin American Space Policy

To guarantee the effective development of space policy in Latin America, the implementation of technological infrastructure, talent training and promotion of private investment are required.

4.6.1 Infrastructure and Technology

In this area, the development of a Network of Aerospace Innovation Centres is essential.

- **Brazil and Argentina:**
  - They will lead the manufacture of rockets and propulsion systems, taking advantage of their experience in projects such as the VLS and Tronador II;
  - They will create test platforms and propulsion laboratories in collaboration with universities and the private sector.

- **Mexico and Chile:**
  - They will develop satellite sensors, navigation systems and advanced electronics for observation and telecommunications satellites;
  - They will boost the production of key components for nano satellites and telecommunications systems.

- **Ecuador, Colombia and Peru:**
  - They will specialize in earth observation applications and satellite data analysis for environmental monitoring and natural disaster management;
  - Establishment of a regional centre for remote sensing and geospatial analysis for natural resource management.

The construction of a Latin American Spaceport in Alcântara (Brazil) is also important.

- **Strategic location:** Located near the Equator, which enables launching costs to be reduced by 30% due to the speed of the Earth's rotation.

Figure 7 – Alcântara Space Center

Source: ASC (2012).

- **Sharing:** Ability to launch commercial, scientific and defence satellites from a platform managed by the ALCE.
- **International collaboration:** Allow the use of the port by foreign space agencies, which generates income and consolidates Latin America as a relevant player in the aerospace sector.

4.6.2 Human Capital Education and Training

It is essential to create a Latin American Aerospace Engineer Training Program in which you can find:

- **Network of universities with space engineering programs:**
  - Expansion of aerospace, telecommunications and astrophysics engineering programs in public and private universities;
  - Creation of research centres in collaboration with ALCE and international agencies.

- **International Scholarships in Space Agencies:**
  - Establishment of exchange agreements with NASA, ESA, CNSA (China), JAXA (Japan) and Roscosmos (Russia);
  - Fellowship and internship program to train engineers and scientists in satellite and propulsion system technology.

- **Exchange of scientists and professionals within the region:**
  - Implementation of a mobility program to strengthen cooperation between aerospace innovation centers in Latin America;
  - Creation of joint research and development projects, with the participation of experts from different countries.

4.6.3 Private Sector and Space Commercialization

The creation of a Special Space Economic Zone in Brazil and Argentina would contribute:

- **Tax benefits for aerospace companies:**
  - Tax reduction for startups and corporations that develop satellites, *Software* aerospace and rockets;
  - Customs incentives for the import of space materials and equipment without tariffs.

- **Infrastructure for *Startups* Aerospace:**
  - Creation of incubation centers and accelerators for aerospace companies in collaboration with universities and government agencies;
  - Support for start-ups in the development of nanosatellites, propulsion and space telecommunications technology.

- **Incentives for the manufacture and launch of commercial satellites:**
  - Implementation of a subsidy and financing program for companies that design and operate commercial satellites in Latin America;
  - Creation of a regional market for satellite services, promoting the use of national satellites in telecommunications, agricultural monitoring and environmental surveillance.

4.7 Evaluation and Monitoring of Space Policy

To ensure the effectiveness and continuity of the **Latin American Space Plan 2030**, it is essential to implement a **Monitoring and evaluation system** that allows its impact to be measured and strategic adjustments to be made.

4.7.1 Creation of the Latin American Space Observatory (OEL)

This **Autonomous technical body** is in charge of supervising the implementation of space policy in Latin America, made up of representatives of ALCE, national space agencies, universities, the private sector and experts in space geopolitics, and established as a Open Data Center, in which the scientific community and society can access information on regional space development.

4.7.2 Monitor the progress of the Latin American Space Plan 2030

In this item, it is worth highlighting some aspects: Evaluation of Key Performance Indicators (KPIs) –such as: Number of satellites launched and operational; Progress in the development of rockets and launch vehicles; Impact of space infrastructure on telecommunications, meteorology, security and agriculture; Growth of human talent in aerospace careers – and implementation of Control and Auditing Systems, ensuring transparency in the use of resources.

4.7.3 Publish annual reports on investment, missions launched and international cooperation

To do this, the production of an Annual Report on Latin American Space Policy, including: Budget execution and sources of financing (state, private and multilateral); Space Mission Overview carried out by each country and international cooperation projects; y State of infrastructure development such as the Spaceport in Alcântara and the Aerospace Innovation Centers.

The publication of a *Ranking* of technological advances, Enabling the performance of each country to be compared in relation to its space objectives; and the dissemination of results in **International conferences**, strengthening Latin America's position on the global space agenda.

4.7.4 Recommend adjustments in policy according to technological and geopolitical developments

This item includes analysis of global trends in space exploration, satellite defense, space commercialization and new regulatory frameworks; elaboration of proposals for improvement to adapt the Latin American Space Plan 2030 to:

- New technological opportunities, such as artificial intelligence applied to satellites and space mining;
- Changes in the geopolitical context, optimizing strategic alliances with space agencies from other continents;
- Innovations in financing, exploring schemes such as space bonds and advanced public-private partnerships.

And in addition, the organization of annual review forums, in which international experts evaluate the evolution of Latin American space policy.

5 DISCUSSION

The data in the argumentative development show the rapid consolidation of space as a new front of geopolitical competition, in which nations such as the United States, China and Russia deploy satellite and anti-satellite capabilities to strengthen their strategic presence. As Samson and Cesari (2022) point out, the threat of militarization is reinforced by anti-satellite weapons testing (ASAT) and the rise of space forces, in an environment in which early detection and orbital superiority represent tactical and technological advantages (Golia, 2025). Under this logic, a challenge arises for Latin America, whose limited investment and institutional fragmentation prevent it from competing on equal terms, exposing it to a strong dependence on key services such as communications, environmental monitoring and satellite security.

The graphs in the statistical analysis section reinforce this problem. The evolution of government spending on space programs (Figure 2) shows that the United States leads investment with almost 80,000 million dollars in 2024, while China, Russia, and other actors invest significantly smaller amounts. However, Latin America is not among the main investors, suggesting a lack of priority in the development of its spatial autonomy. This translates into greater technological dependence and limited access to its own satellite services.

On the other hand, Latin American space initiatives show isolated progress in the development of their own satellites and collaboration with foreign powers, but they lack a regional integration strategy that allows for the optimization of resources and the sharing of risks (AEM, 2019; Conae, 2020). Thus, scientific cooperation and space diplomacy, raised in international forums (Treaty ..., 1966), have not yet managed to translate into a far-reaching joint policy. In addition, the incipient participation of the private sector in the region contrasts with the boom of aerospace companies in the United States and Europe, generating a lag in competitiveness and the generation of technological innovation (Gréková, 2017).

The proposal for a Latin American Space Plan 2030, based on the *Policy Cycle*, emerges to join forces, jointly manage a financing fund, and coordinate the creation of regional infrastructure (e.g., satellite constellations, rocket development, and a spaceport). Joint work would also facilitate the specialization of different countries in specific tasks, such as the construction of satellites, the manufacture of propellants, and environmental monitoring, which would have a positive impact on technological sovereignty and the training of human talent (Bolaños Ramírez; Jiménez Vélez; Noboa González, 2022). Given the risk of militarization and the need to regulate activities such as asteroid mining or waste management, regional alignment also allows common positions to be articulated vis-à-vis the main powers and multilateral forums (Simberg, 2012).

Along these lines, the articulation of a regional legal framework that complements the UN treaties (1967 Outer Space Treaty, 1972 Convention on Liability, etc.) would represent a step towards true Latin American space governance. The creation of a Regional Framework Law on Space Policy, accompanied by a shared Satellite Registry and debris mitigation standards, would lay the foundation for effective and sustainable cooperation. However, for these initiatives to prosper, a long-term political commitment, the active participation of national space agencies and the financial support of regional organizations such as the IDB or CAF are essential. If these conditions are met, Latin America could build a system of space security and development with a view to technological sovereignty and global competitiveness.

The multi-domain approach is not only relevant in terms of defense, but also in the integration of dual technologies (civil and military), the coordination of space agencies, and the optimization of regional resources. Interoperability between armed forces, space agencies, and the private sector could be key to the development of an effective space policy in Latin America, ensuring that investment in satellite infrastructure benefits both security and technological and economic development. The lack of current regulations and the development of disruptive technologies in outer space create an environment of uncertainty, in which nations that do not adapt will be left at a disadvantage. Various analyses agree that States that fail to develop minimum space capabilities, either nationally or regionally, will be relegated to a marginal role in multi-domain security and in the new space economy, depending on external providers both for critical services and for the definition of rules of the game (Bowen, 2020; Jakhu; Pelton, 2017; Johnson-Freese, 2007).

An example of how this logic of strategic autonomy and the construction of minimum capabilities is beginning to materialize in the region is the case of Brazil, which in 2025 created the Empresa de Projetos Aeroespaciais do Brasil S.A. (ALADA) as a public company linked to the Aeronautics Command, with the mandate to develop and commercialize aerospace technologies and to economically exploit launch infrastructures. In parallel, the partnership with the South Korean company Innospace for the launch of the HANBIT-Nano rocket from the Alcântara Space Center illustrates a dual strategy: on the one hand, to reduce technological dependence by strengthening the national space program and, on the other, to insert the country into the international market for launch services, taking advantage of geographical advantages and synergies with extra-regional partners (AEB, 2012; ALADA ..., 2024; Brazil, 2025). These types of initiatives point to a possible path for other Latin American countries and reinforce the argument that a Latin American Space Policy and the consolidation of the ALCE could articulate dispersed national efforts in a coherent regional strategy in the face of multi-domain security and the new space economy.

6 CONCLUSIONS

Space has become an area of geopolitical competition, with great powers increasingly investing in defense and exploration capabilities. This dynamic means that satellites, launch capabilities, and manned missions are no longer limited to scientific or commercial purposes, but are part of the logic of security and technological sovereignty.

Although there are treaties sponsored by the UN, there is a regulatory gap that does not adequately regulate new technologies (anti-satellite weapons, mega-constellations, space mining) or the growing intervention of private companies. This lack of updating fosters risks of arms escalation and disputes over appropriation rights to resources on the Moon or asteroids.

The analysis of the data shows how space has evolved from being an area of scientific exploration to becoming a key geopolitical and strategic sector, with both military and economic implications. Figure 5 evidences that NASA's annual budget has shown an increasing trend in recent decades, reflecting the United States' renewed interest in consolidating its presence in space, while other powers have followed a similar trajectory in their investment. However, Latin America continues to lag, without clear investment or a coordinated program that enables it to compete in this environment.

Although countries such as Brazil, Argentina and Mexico have developed their own space agencies and satellite programs, the region is fragmented and with a lower level of investment than that of the powers. This lack of coordination hinders the adoption of large-scale projects and perpetuates reliance on external providers for communications, observation, and critical data management.

The proposal to apply the *Policy Cycle* in the formulation of a Latin American Space Policy offers a clear and sequential roadmap: identification of priorities, formulation of joint plans, adoption of shared financing structures, implementation of regional projects and permanent evaluation of results. This methodological approach increases efficiency and transparency in decision-making.

The adoption of a common space plan would allow Latin American countries to reduce the technological gap, strengthen sovereignty in the aerospace field and foster an innovation ecosystem that generates employment and competitiveness. However, achieving these goals requires long-term political commitment and overcoming economic and institutional asymmetries in the region. In addition, science diplomacy and active participation in multilateral forums are key to negotiating clear rules on space mining, mitigation of debris in orbit and prevention of military conflict in space.

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