International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Unlocking India's Space Economy: Frugal Innovation and Private Sector Integration

Hemant Jain[1], Dhruvi Bharwad[2]

[1]Scientist/Engineer, Space Applications Centre, ISRO
[2]Social Research Officer, Space Applications Centre, ISRO

ABSTRACT

With the global space sector's increasing democratization, new business opportunities are flourishing, driven by innovative startups. Historically, India's space R&D and commercial activities have been ISRO-centric, a testament to its consistent global achievements. However, recent regulatory reforms mark a new era for Indian space science and technology. These transformative policy and legislative changes aim to unlock the sector's full potential, ensuring an equitable environment for emerging small and medium enterprises and startups. This paper discusses the frugal implementation of these Space and Geospatial Policies, which emphasize incremental private industry participation throughout the space ecosystem's value chain. The ultimate goal is to significantly enhance India's economic contribution to the global space industry.

1. INTRODUCTION

Space sector in India is thriving with transformational reforms. These reforms were introduced during post Covid-19 economic revival initiatives. Indian economy GDP fall was record lowest at 23.9 percent, which the Reserve Bank of India called “historic technical recession”. As part of economy revival initiatives the Government of India opened up space sector for private participation during its historic reforms declared in June, 2020[1]. Subsequently National Geospatial Policy was introduced on December 08, 2022 and the Indian Space policy was introduced on April 20, 2023.

So far, the Indian space segment has been dominated by state owned entity – Indian Space Research Organization (ISRO) formed in 1969. The Indian Space program has had few distinct elements as satellites for communication, navigation, remote sensing, the space transportation system, and application programs[2]. ISRO has been responsible for end to end space activities in India. ISRO’s magnitude of activities was ranging from focusing on R&D, manufacturing the operational space systems, ensuring space based communication services, producing data products and applications to establishing and managing telemetry, tracking and command earth stations and satellite control centers. Hence it has been amalgamation of all space related services and technologies. The private participation has mainly been limited to vendor development. It has been a long-standing demand of the private sector to liberalize the

[1] PIB, Historic Reforms Initiated in the Space Sector – Private Sector Participation in Space Activities Approved, June 24, 2020
[2] Developing the space eco-system in India: focusing on inclusive growth, EY Report, October 2022

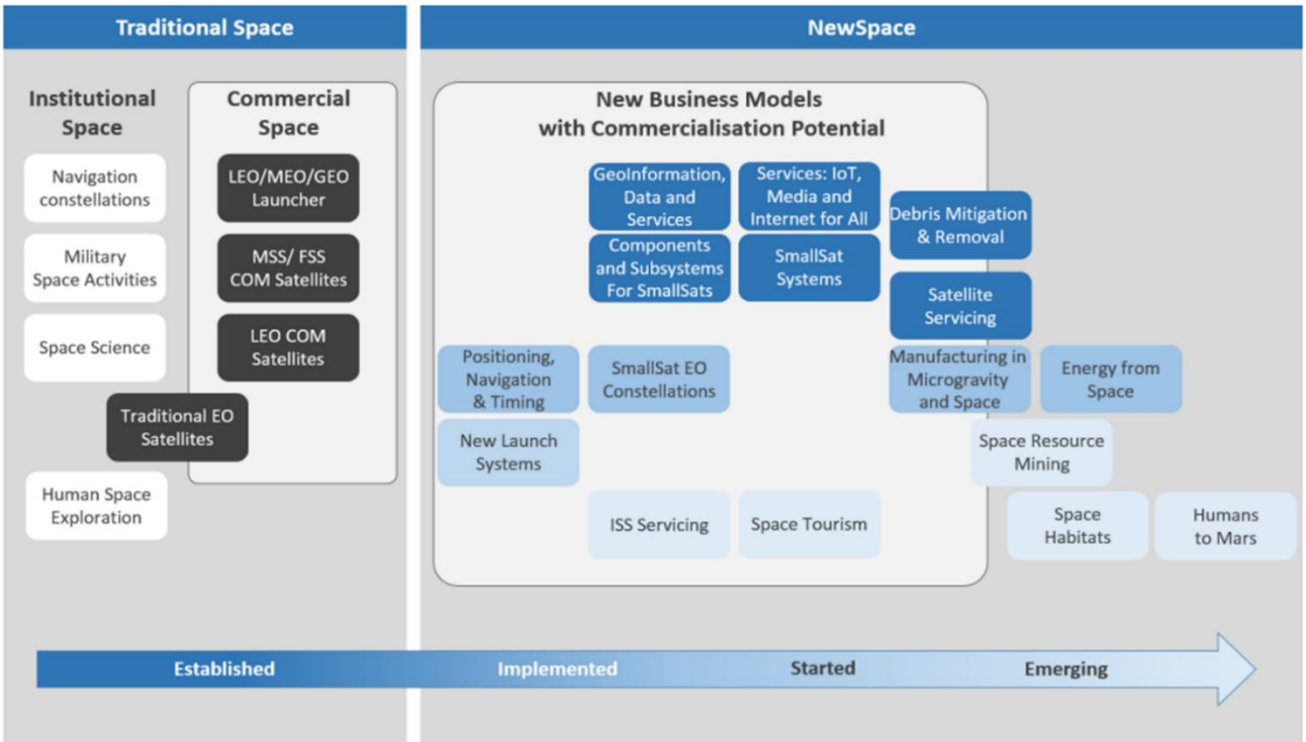
governing regulatory norms to open up the sector so as to realize the full potential of India's space capabilities[3].

The major objective of the reforms is to create an environment that accelerate India's share in global space economy from 2% to 10% in future. It further aims at augmentation of private space industry towards manufacturing operational space systems. These initiatives are acting as impetus towards a major goal i.e. increasing the market share of India in world's space economy exponentially.Indian Space Policy 2023 and National Geospatial Policy 2022 frameworks are mainly focusing upon commercialization of space technology, boost participation of private industry and private investment,preparing youth to be space leaders, encouraging adaptation and development of innovative technology. It is necessary to understand these policies critically to interpret the roles & responsibilities of eachstakeholder associated with space technology sector.

The paper aims at understanding the recent paradigm shift at policy level and how it led to transformational approach in the space science and technology domain. This transformative approach at the policy and legislation level is aimed at unlocking the potential of space sector with the implementation of two policies – the Indian space policy 2023 and the national geospatial policy 2022. Its implementation will not only provide equal playing field to new small & medium enterprise but also to the startups who are eager to reconnoiter the endless boundaries of space. The paper further recites about the adaptation of Frugal Approach for implementing the Space Policy and Geospatial Policy with a vision to maximize the economic share of India in the global market.

2. TRENDS OF SPACE INDUSTRY: A GLOBAL OVERVIEW

The "Traditional Space" industry refers to the legacy of historical structure and operational model of space



[3] Developing the space eco-system in India: focusing on inclusive growth, EY Report, October 2022

sector. It emerged and evolved largely in the post-World War II era, heavily influenced by the Cold War space race between the United States and the Soviet Union. Majority of projects and funding came from national governments and their space agencies. These space sector related activities were driven primarily by scientific exploration, national prestige, and military/national security interests. Satellites and launch vehicles were largely custom-designed and built for specific, often one-off, missions. The industry did see the early commercialization of satellite communications (e.g., for television broadcasts, long-distance telephony) in the latter half of the 20th century. However, this was often still heavily reliant on government-developed infrastructure and launch capabilities. In essence, the traditional space industry was characterized by a monumental scale, strategic importance, and a painstaking, meticulous approach driven by government mandates and scientific ambition. While it achieved incredible feats and laid the groundwork for all subsequent space development, its high barriers to entry and slow pace created the conditions for the emergence of the "NewSpace" movement, which seeks to disrupt these traditional paradigms. The initial three decades can be termed as traditional era whereas the later can be termed as contemporary era. The gradual transformation in the activities can be depicted from the following diagram[4]:

With the advancement of technology and emergence of new space horizons there has been gradual transformation in space industries globally. The focus transcended from building satellites to adding commercial edge with multiple applications. The global space industry has matured to nearly 6.5 decades since 1957 till present. Convergence of technologies, advancement in process and diversity in product have established a new business model to exploit the commercial potential of space segment. Modern day information technologies such as Big Data Analytics, Cloud Computing etc. are used to simplify ground station solution and beaming imagery data at affordable price. In the contemporary era, the focus is more upon emerging activities possessing supplementary commercial valuation along with scientific edge. Space tourism is one such activity which has attracted attention of most of the stakeholders. Energy from space, resource mining from asteroids & planetary surface, quantum communication-based secured satellite etc. are few projects where across the globe research is at full swing. There is huge amount of potential exploration is carried out on identification & development of commercial components having multiple application. The genesis of exploration in space technology started with quest to unleash the science behind it. But today unlocking the potent commercial valuation of space sector is prime motivation as it has impact on economic as well as social factor of human generation.

3. INDIAN SPACE POLICY 2023 FRAMEWORK

Indian Space Policy introduced in April 2023, significantly has three stage pyramid strata i.e. Strategic, Tactical and Operational. At strategic level, the prime aim is to sanction focused and predictable regulatory framework. The focus is upon encouraging participation of private industry on selective domain of the sector and increase the nation capabilities. This in turn will nurture the holistic growth of the space-technology based services in India. Tactical strata of the policy are more inclined towards bringing clarity on roles & responsibilities of each stakeholder. The policy clearly addresses the activities to be carried out

[4] Techno-Commercial Aspects of Space-Based Startups Ecosystem in India. In Advances in Small Satellite Technologies (pp. 475-489). Springer, Singapore. https://doi.org/10.1007/978-981-15-1724-2_45

by ISRO, IN-SPACe- Indian National Space Promotion & Authorization Centre (IN-SPACe), New Space India Limited (NSIL) as well as private entities. ISRO, as the National Space Agency, will focus primarily on research and development of new space technologies and applications, and for expanding the human understanding of outer space[5]. IN-SPACe shall function as an autonomous Government organization, mandated to promote, hand-hold, guide and authorize space activities in the country. For this purpose, IN-SPACe shall periodically issue guidelines and procedures, that would among other things promote ease of doing business[6]. NSIL shall be responsible for commercializing the space technology and platforms created through public expenditure[7].* Long-term planning is reflected as emphasis on futuristic mission such as commercializing the asteroid mining is spelled-out. Lastly, at operational level, giving equal opportunity to private entity and access to expertise of ISRO is deliberated. Policy advocates the usage of facilities & technical infrastructure of ISRO by NGEs and Start-ups at subsidized cost and incentivize these early adaptors of the space sector.

4. NATIONAL GEOSPATIAL POLICY 2022 FRAMEWORK

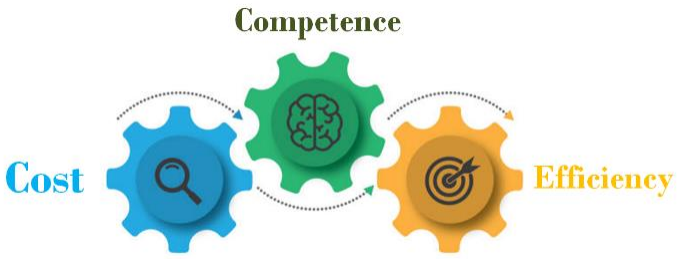
National Geospatial Policy 2022 focuses upon structuring the policy and legal system for liberalizing geospatial and remote sensing sector of India to realize its importance for national growth. Space policy provides the "eyes in the sky" – the satellites and technology to capture vast amounts of geospatial data. Geospatial policy then ensures this invaluable data is processed, standardized, and made readily available for actionable insights, fostering innovation and economic activity on the ground. Space technology provides the raw materials (satellite imagery, navigation signals), and geospatial policy enables their transformation into actionable intelligence. For example, satellite imagery (space policy) is used to create detailed land-use maps, assess crop health, or monitor environmental changes (geospatial policy applications). As the space sector expands with increased private participation, more satellite data will become available. The liberalized geospatial policy creates a demand for this data by enabling businesses and startups to develop innovative geospatial products and services, thus creating a vibrant market for space-derived information. This creates a virtuous cycle where advancements in space technology fuel the geospatial economy, and vice-versa.

National Geospatial Policy 2022 portraits the varied milestones to be achieved at specific timeframe. By 2025, there is a planning to have integrated interface and platform for all digital data. The digital data will be accessible to all the majority stakeholders and enterprise across domains. By 2030, the focus is upon developing Geospatial Knowledge Infrastructure (GKI). This will be done completed through high-resolution topographical surveying and mapping. By 2035, there is an optimistic view point on having a Digital Twin of all the assets i.e. inland water, sea surfaces, infrastructures etc., having national priority. The major objective which can be achieved through introduction of Geospatial Regulatory Framework is the conversion of plethora of information stored in digital images into actionable work[8].

[5] The Indian Space Policy, 2023
[6] The Indian Space Policy, 2023
[7] The Indian Space Policy, 2023
[8] National Geospatial Policy, 2022

5. FRUGAL APPROACH

Both the policies i.e. Indian Space Policy 2023 and National Geospatial Policy 2022, has adopted a frugal approach. State- funded organization has always been the nodal agency for leading the space programme in India. From conceptualization to implementation, government organization and its allied arms were responsible for the addressing the prime national agenda through space technology. At global frontier, to get a competitive edge, egalitarian platform through these policies is introduced. These frameworks have multi-method ideology and their epitome functional criteria are Cost, Competence and Efficiency.



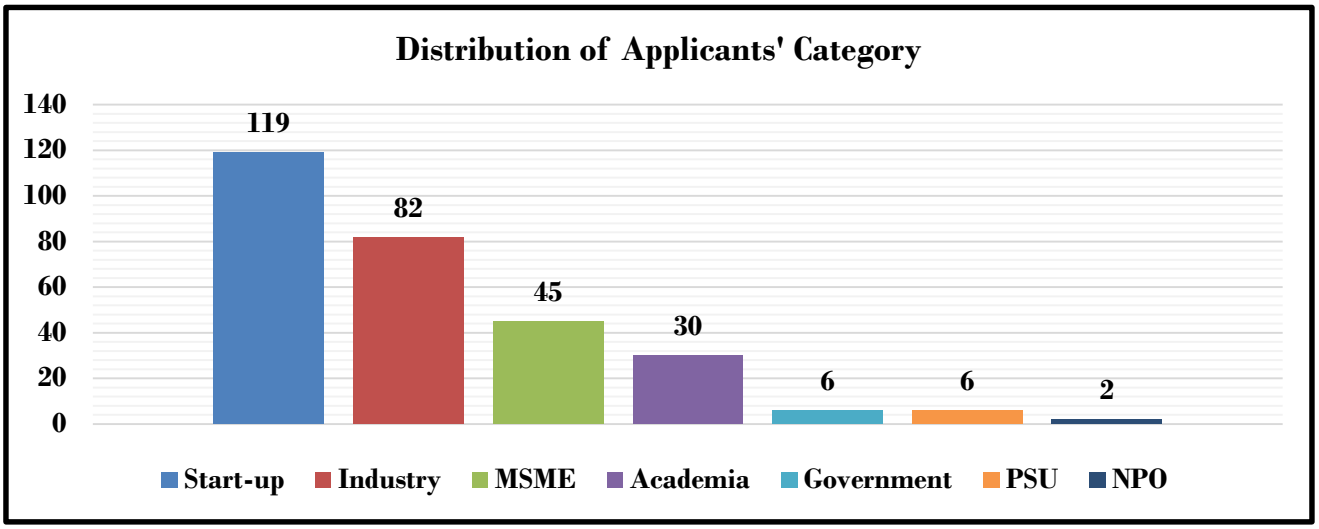
Moreover, the space technology sector is niche and capital intensive. Infusion of funds and resources for longer gestation tenure is one of the characteristics of this kind of market. There is a necessity of optimum utilization of resources for reduction in the cost. It has been addressed by providing access to the facilities / infrastructure developed through public expenditure to private industries (SMEs, MSMEs, Startups etc.). Implementation of differential pricing mechanism i.e. providing subsidy and incentive to all the new entrant of space domain, has resulted in reduction of development and manufacturing cost. Eventually it has brought economies of scale for those space technology-based product & services where consumer in abundance is served.

There are multifaceted challenges that impairs the space industry as a whole. The complexity and criticality of design and development of scientific payloads or instruments associated with space sector is one of the challenging aspect. In-depth knowledge and high precision are pre-requisite for such innovations. The emphasis is laid upon the pragmatic tactic to focus upon the complexity associated with cutting-edge technologies. Another crucial factor is capacity building and retention of the adroit human resource. It also plays a key role to mitigate the lag in turn-over rate of actual scientific outcomes. In academia & research institutions, introduction of specialized aerospace segment curriculum and training is also encouraged nowadays. Eventually the competence gained across all domains of the space sector will accelerated the economic growth.

It is evident that monopolistic market dynamics in long run will not have desired consolidate output. These policies aim at fostering the environment wherein the state-owned R&D organizations along with new-age enterprise can foray into the democratized work forums. Moreover, these policies are oriented towards the evolution of the market by increasing participation of private industry and increasing the efficiency. Hence it can be stated that the exponential increment in the efficiency of the space industry in India will results in augmented share of global economy.

6. UNLOCKING OF SPACE SECTOR

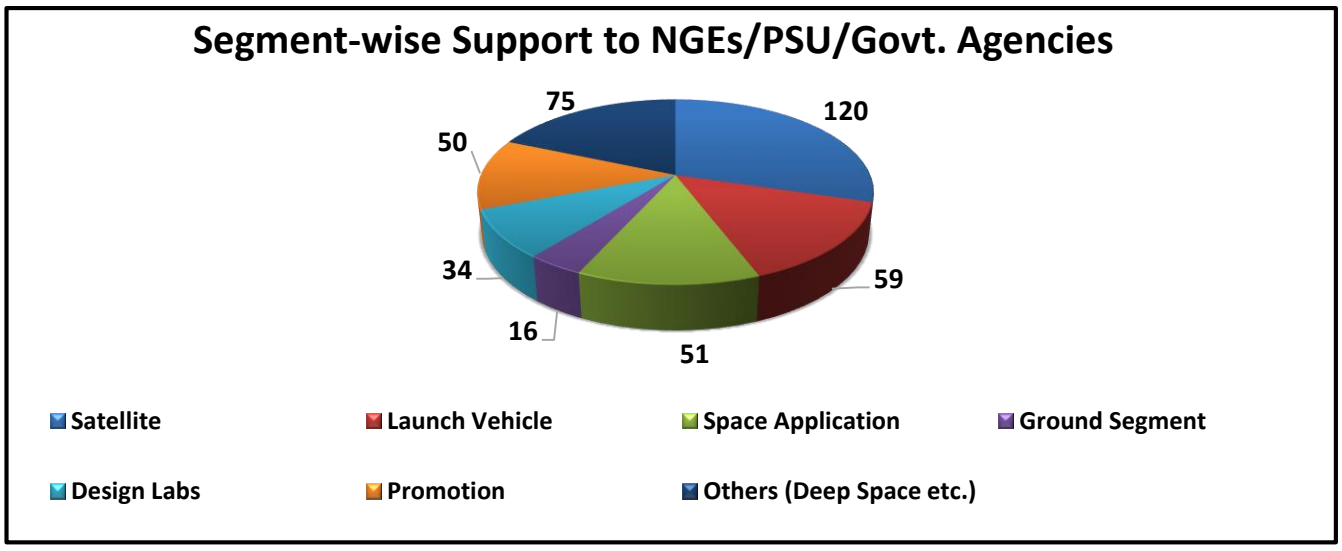
Post sectorial reforms, large number of new-age enterprise has plunged into the space science technology to explore & exploit the undiscovered commercial potent of the sector. After the announcement of the reform phase and the formation of IN-SPACe, 290 applicants under various entity category applied for the support & authorization through IN-SPACe[9]. Most number of applicants were Start-ups, followed by private industry and Micro, Small and Medium Enterprises (MSMEs). A keen interest is expressed by researchers from academia in anticipation of collaboration for conceptualizing the futuristic and cutting-



edge technologies as reflected in following graph:

(Figure 01: Distribution of Applicants category, Data **Source: - IN-SPACe Dashboard[10])**

Space technology sector have multiple specificities. All the segments are inter-dependent and converging. As reflected in the above chart 01, maximum number of support request is from the area of satellite development.



[9] https://www.inspace.gov.in/inspace?id=inspace_nge_dashborad
[10] https://www.inspace.gov.in/inspace?id=inspace_nge_dashborad

(Figure 02: Segment-wise Support to NGEs/PSU/Govt. Agencies, Data **Source: - IN-SPACe Dashboard[11] ***

It comprises of consultancy in design and development of payload related to communication and remote sensing satellites. There has been significant request received in launch vehicle and space applications domains. Both the segments are vast and critical. IN-SPACe has established space system Design Lab for private sector participants to give them access to the capital intensive & niche software's, test facilities etc. Encouraging response has been received from start-ups & SMEs to avail this facility. There are few new-age technologies driven start-ups who are focusing upon deep-space exploration & services. They are at conceptualization stage and have approached ISRO for detailed review & analysis consultancy for their futuristic projects.

This phase of reforms & unlocking the potential of space sector in India has brought in confidence amongst the private equity venture capital. There has been surge in the investment inflow in the potent space-technology based startups in India. The number of space start-ups registered in India has been accelerated from 1 in 2014 to 189 by end of 2023[12]. The investment in these new-age tech companies has been increased to ₹124.7 million in 2023[13]. As per policy, 100% FDI is allowed in satellite establishment and operations under Government route. As new initiative under the aegis of this policies, Seed Fund Scheme has been initiated by IN-SPACe to provide financial assistance to selected start-ups. Lastly, these space-technology related policies are indirectly having impact on various Government funded schemes, such as, Make-in-India, Digital India, Smart-City etc. The progress in these welfare scheme will be subtle

7. CONCLUSION

In conclusion, the transformative policies governing India's space sector have successfully ushered in an era of heightened **private engagement and capital infusion**. This paradigm shift is broadening India's ambition from purely 'Space-for-Earth' applications—which traditionally focused on societal benefits—to embrace a burgeoning **'Space-for-Space' economy**, unlocking new commercial frontiers in orbit and beyond. The distinctive **frugal approach** embedded within the Indian Space Policy 2023 and National Geospatial Policy 2022 is a cornerstone of this success. By strategically enabling cost-effective access to critical resources and expertise, these policies are democratizing space for small and medium enterprises and startups alike. This comprehensive policy framework is fostering an innovation-driven ecosystem poised to not only reduce the digital divide and enhance national welfare initiatives but also significantly boost India's global competitiveness and economic footprint in the rapidly expanding space industry.

Bibliography

1. Ernest & Young, Developing the space eco-system in India: focusing on inclusive growth, October 2022
2. National Geospatial Policy 2022
3. Indian Space Policy 2023

[11] https://www.inspace.gov.in/inspace?id=inspace_nge_dashborad
[12] https://dpiit.gov.in/starup-india/startup-india-intiatives
[13] https://dpiit.gov.in/starup-india/startup-india-intiatives

4. Prasad, N., & Rajagopalan, R. P. (2017). Space India 2.0: Commerce, policy, security and governance perspectives, Observer Research Foundation
5. NewSpace - Emerging Commercial Space Industry and New Technologies, Geospatial World, July 12, 2018, www.geospatialworld.net/article/emerging-commercial-space- industry-new-technologies/.
6. Retrieved from https://www.isro.gov.in/indian-national-space-promotion-and- authorization- center-space/space-structure
7. Jain, H. M., & Rana, Y. P. (2020). Techno-Commercial Aspects of Space-Based Startups Ecosystem in India. In Advances in Small Satellite Technologies (pp. 475-489). Springer, Singapore. https://doi.org/10.1007/978-981-15-1724-2_45
8. PWC Report "Preparing to scale the new heights: Enhancing private participation in India's Commercial Space Sector", Jan 2020
9. Abrar, P., Ahmad, S., & Babu, G. "India's Aerospace Start-Ups Eye Rocket Launches and Planetary Missions." Business Standard, June 26, 2020, https://www.business-standard.com/article/companies/india-s-aerospace-start-ups-eye-rocket-launches-and- planetary-missions-120062601687_1.html.
10. Main Trends & Challenges in the Space Sector 2nd Edition. (2020). https://www.pwc.fr/fr/assets/files/pdf/2020/12/en-france-pwc-main-trends-and-challenges-in-the-space-sector.pdf
11. PricewaterhouseCoopers. (n.d.). Main Trends & Challenges in the Space Sector. PwC. Retrieved January 5, 2024, from https://www.pwc.fr/en/industrie/secteur-spatial/pwc-space-team-public-reports-and-articles/main-trends-and-challenges-in-the-space-sector.html
12. Desk, N. (2022, January 6). Euroconsult releases "Government Space Programs" report for 2021. Geospatial World. https://www.geospatialworld.net/news/euroconsult-releases-government-space-programs-report-for-2021/
13. Coykendall, J., Hardin, K., Brady, A., & Hussain, A. (2023, March 22). Riding the exponential growth in space. Deloitte Insights. https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/future-of-space-economy.html
14. World, G. (2023, January 3). National Geospatial Policy Aims to Transform Indian Innovation by 2035. Geospatial World. https://www.geospatialworld.net/prime/national-geospatial-policy-indian-innovation-2035/