Zeszyty Naukowe Uniwersytetu Jagiellońskiego
Prace Etnograficzne 2025, 53, s. 39–58
doi:10.4467/22999558.PE.25.003.23087
www.ejournals.eu/Prace-Etnograficzne/

Rashmi Moolampalli
Institute of Ethnology and Cultural Anthropology
Jagiellonian University
e-mail: pmrashmi87@gmail.com

Shaping Gender-inclusive Space Sector in India: Policy Insights and Strategies

Abstract

Recent ISRO initiatives have shifted the narrative where the prominence of women in space science is highlighted. Despite this the gender gap persists as a challenge that can impede India's goal of becoming a space-faring developed nation by 2047. Therefore it is imperative to achieve a diverse and sustainable talent pool ensuring equitable opportunities and participation of all. Through multimodal digital ethnography this research analyzes the media portrayals of women scientists and gathers insights from various stakeholders on issues such as media impact on personal life and in shaping public perceptions, workplace dynamics, and work-life balance. It also reviews key government STEM policies promoting participation of women. The study proposes three policy recommendations: embed gender equity in space policy, normalize women's roles in the sector, and promote inclusive media content.

Keywords: India, space policy, space sector, ISRO, women, gender-inclusivity

Introduction

India entered space exploration with the establishment of the Indian Space Research Organization (ISRO) on August 15, 1969. During this period, India struggled with severe social, economic, and political challenges (Radhakrishnan, Manoranjan Rao 2012). The Indian society was grappling with issues like poverty, superstition, illiteracy etc. Gender discrimination further restricted women from education, workforce participation, and decision-making processes. In 1901, women literacy rate in India was a mere 0.69% (Gurnani, Sheth 1984). According to the census of 2011, this figure reached 64.63%. Space missions require extensive STEM expertise and as per the All-India Survey on Higher Education (AISHE) 2021–22, there is a persistent gender gap in technical education with only 29.1% of the students as female in the engineering and technology stream. The survey revealed significant female representation in science education with 50.8% of students enrolled being female and 49.2% male (Ministry of Education 2022). The gender gap in the technology stream could be attributed to various socio-cultural factors, such as traditional career perceptions, societal expectations towards women, and lack of awareness.

World Economic Forum's report on Global Gender Gap 2024 (Pal et al. 2024) illustrates the underrepresentation of women in STEM roles. Though women participation in both non-STEM and STEM workforce has increased since 2016, only 28.2% of women are in STEM fields compared to 47.3% in non-STEM roles. UNESCO's recent global education monitoring report "Technology on her Terms" points the static proportion of women graduates in STEM, which has remained at 35% for the past ten years (UNESCO 2024). Another report underscores the disproportionately lower rate of female student enrolment in STEM related fields, highlighting a significant gender gap in education and career pathways (UNESCO 2017).

India envisions to become a developed nation in the space sector by 2047, and significant steps have been taken in terms of technological development, international collaborations, commercialisation of space sector, and enhancing space exploration missions (Department of Space 2024a). Moreover, India's Prime Minster Sri Narendra Modi reference to the touchdown point of Chandrayaan 3 as "Shiva Shakti" symbolizes India's growing stature as a space faring nation (ISRO Official 2023). The name draws from Hindu spiritual tradition: Shiva represents consciousness and transcendence, while Shakti embodies energy, dynamism, and creative power.

However, despite making outstanding progress in space exploration, women continue to be underrepresented in strength and key leadership roles of the space sector. This gender gap presents a serious challenge for India to achieve its vision by 2047. Therefore, a diverse workforce is a prerequisite for ensuring a sustainable talent pool of expertise, knowledge, and skill. The present study offers policy recommendations for creating a gender-inclusive space sector based on key insights gathered from exploring the perceptions of space scientists and STEM students, alongside analysing various secondary sources. This research also probes into the contributory role of media in enhancing the participation of young girls in STEM fields. The research is primarily empirical in nature, drawing on in-depth interviews with scientists, workplace observations, and documentary analysis.

Gender in Space Exploration – Historical Context

The early era of space exploration was shaped mostly by the intense rivalry between the two Cold War superpowers, the United States of America and the Soviet Union.

Predominantly referred to as the “space race,” this period was characterised by groundbreaking space missions. However, this phase also reflected broader societal structures of the time, including gender disparities. Men overpowered the space sector, with women excluded from key positions. Gibson’s (2014) book provides a historical account of women who played a significant role in space missions. She explains that although America had capable women, societal norms at the time saw women as delicate beings who needed protection and care, notions that conflicted with the idea of women becoming astronauts.

Early human space missions were male dominated, with women included much later. Jerrie Cobb, a pioneering female pilot, excelled in NASA’s astronaut tests but was barred from becoming an astronaut due to gendered institutional barriers, as women were excluded from the required military jet experience (Arrighi 2023). The Soviets on April 12, 1961 launched Vostok 1 with a Russian cosmonaut Yuri Gagarin becoming the first human in space. A month later the U.S launched Allan Shepherd into space with Freedom 7. However, it took two years for the Soviets and 22 years for the U.S to put their first woman into space. In 1963 Valentina Tereshkova became the first woman in space from the Soviet Union. While the U.S. followed with Sally Ride in 1983, marking a gradual shift as women gained access to STEM fields, especially following the 1964 Civil Rights Act, China sent its first female astronaut in 2012, and India, still awaiting its first female astronaut through the Gaganyaan mission, has already celebrated Kalpana Chawla and Sunita Williams as notable pioneers.

ISRO has made significant efforts to promote equal opportunities for individuals from diverse backgrounds, specifically focussing on women. Gurnani and Sheth (1984) discuss the gender disparity in India’s scientific community including ISRO and similar organizations. The study highlights the underrepresentation of women in leadership roles as a major problem that requires policy intervention. It also points that the dual responsibilities of work and traditional roles often hindered women from realizing their full potential. However, women scientists in ISRO increased from 2.6% in 1976 to 4.5% in 1980. Currently women scientists constitute 16% of the total employees in ISRO (ISRO 2024). There has been a notable increase from 13.9% in 2011 to 15.2% in 2014, marking the beginning of an upward trend in female participation. As commended by the Vice-President of India, Shri Jagdeep Dhankhar, on International Women’s Day, ISRO was praised for ensuring gender diversity and inclusivity in its decision-making process, setting an example for others to follow (Vice President’s Secretariat 2024). Although only a few women hold senior positions, the women scientists of ISRO have set standards by demonstrating their skills and excellence in space research. The GSAT-12 communication satellite primarily designed to meet the increasing communication requirements for telemedicine and tele-education for India was completely launched by an all--women core team of ISRO in 2011 (Bhatia 2015). Women also played a critical role during the launch of the Technology Experiment Satellite (TES) which was launched in a remarkably short duration of two years to support Indian soldiers (Singh Gulbir 2017).

Methodology

A multimodal ethnographic approach (Dicks et al. 2006) was used to understand how India's space exploration portrays the contributions of women scientists. It involved content analysis of social media platforms such as X (Twitter), LinkedIn, YouTube, and blogs, focusing on posts, videos, and discussions highlighting women's roles in the space sector. The social media dataset covered content posted between 2010 and 2024, allowing the study to trace how representations of women evolved over time. The analyzed online platforms included ISRO's official YouTube channel and X (Twitter) accounts as well as those of popular space enterprises such as Agnikul, Skyroot Aerospace, Dhruva, and Lakshya Space. Selection criteria prioritized posts and videos directly addressing gender, visibility, or workplace participation.

ISRO's digital platforms also served as key sites for gaining official information. In addition, 45 semi-structured interviews were conducted online and offline with current and retired space scientists and engineers. These interviews took place during the period between September 2023 and May 2025. To gain deeper insights into the perspectives of the younger generation, five focus group discussions were conducted with STEM students between the ages of 20 and 25. Each group consisted of 4 to 10 participants, allowing for interactive dialogue while maintaining manageability. The discussions lasted approximately 60 to 90 minutes and were facilitated using a semi-structured guide that encouraged participants to share their views on gender dynamics in science, aspirations for careers in space research, and perceptions of women's visibility in ISRO and related space enterprises. Interviews with space scientists lasted between 45 to 90 minutes and explored workplace experiences, gender dynamics, and coping strategies. To ensure reliability and depth, interviews were transcribed, anonymized, and thematically coded. Field observations during public outreach events like *Space on Wheels* and *National Space Day 2024* enriched the study, revealing how exhibitions engage audiences and showcase women's contributions.

Further perspectives were gathered from researchers, journalists, and social scientists, broadening the analytical frame. Based on global frameworks such as the UN 2030 Agenda (United Nations 2015) and the UN Women report (Elson, Seth 2019), the study defines gender-inclusive space policies as guidelines that recognize structural and institutional biases while promoting equity and inclusion. In contrast, gender-neutrality avoids gender distinctions altogether (Smith, Bamberger 2021), favouring non-gender-specific language, policies, or representations—for example, using the term "scientists" instead of "male and female scientists."

Given the space sector's competitive nature and regulatory constraints and confidentiality concerns, engaging with the scientists and engineers posed a significant challenge. The study's objectives were therefore clearly explained to potential participants and only those interlocutors who consented were considered for the interviews. Moreover, as mentioned earlier, several online social media contents were accessed for the study. It was ensured to carefully watch the multiple interviews of ISRO's women scientists, former chairman, and media coverage of important missions like Chandrayaan 1, 2, and 3, MOM or Mangalyaan and Aditya L1 for gathering information and further analysis. Podcasts and other relevant digital contents like web articles, reports, and interviews were also viewed to gain additional insights relevant for the study.

Women Scientists of India's Space Missions

Women have long contributed to ISRO's missions but their visibility surged during the 2013 Mangalyaan campaign (Vaid 2019), a pivotal shift in ISRO's traditionally low-profile approach. As space policy expert Namrata Goswami notes, this was the first time ISRO actively promoted a mission to engage the public, particularly youth and potential investors, aligning with India's ambition to become a global space leader. According to ISRO's social media head, BHM Darukesha, while the primary aim was to inspire the younger generation, the campaign unexpectedly brought women scientists into the spotlight. Media coverage amplified their stories and viral images of saree-clad women celebrating the mission captured public imagination, blending tradition with scientific achievement. These representations challenged stereotypes and helped to foster a broader recognition of women's roles in space, marking a meaningful moment in shaping perceptions around gender and science in India's growing space ecosystem.

Insights from retired ISRO scientists and engineers with over three decades of experience provide valuable perspectives on the organization's evolving culture. Most emphasized ISRO's gender-inclusive environment, where roles are assigned based on merit and expertise rather than gender. One remarked, "ISRO emphasizes skills and expertise over gender." Projects are systematically divided, and leadership is determined by individual performance, ensuring equal opportunities for both men and women. Early in ISRO's history women were few, yet they were entrusted with responsibilities equal to their male counterparts. Nigar Shaji, Aditya L1 mission director, and T.K. Anuradha, ISRO's first female project director, echoed similar sentiments. Anuradha recalled that even in the 1980s, when women were rare in engineering roles, they were treated as equals. Pioneering figures documented in Women Engineers in India (Indian National Academy of Engineering 2016), including Valarmathi Natarajan, Lalithambika V.R., and Geet Varadan, contributed to missions like Gaganyaan, MOM, and RISAT-1, highlighting a legacy of excellence.

While high-profile missions like Mangalyaan draw widespread public attention on women and their contributions, an ethnographic look of the daily lives of women scientists' shows a far more complex and nuanced picture of gender dynamics. For many of these women scientists a typical day begins with planning tasks alongside household responsibilities, often with support from family members or domestic help. This careful balancing act underscores the dual demands that women scientists manage, highlighting the intersection of professional and personal spheres in shaping daily routines. Once at the workplace, their immediate priorities are either established or already clear, as some may be engaged in meetings, technical problem-solving sessions, or administrative duties. These structured interactions reflect the formal organization of scientific labour, yet they coexist alongside informal practices that seemed equally important to them. Social networking, peer support, and conversations were meant for informal spaces such as cafeterias and corridors. Notably, many women tended to view these spaces as places for personal interaction rather than professional dialogue. They exchanged stories, expressed concerns, and provided emotional support to colleagues, sometimes avoiding discussions about technical work or mission-related matters.

In addition to examining the lived realities of women scientists there was also an opportunity to meet one of ISRO's most celebrated figures—the first female Programme Director of the Space Transportation System at VSSC. She wore traditional Indian attire just like an ordinary person I might meet in a daily life. She shared candid reflections on her early days at the organization when very few women were present, yet responsibilities were shared equally regardless of gender. She recounted challenges such as the PSLV-D1 failure and highlighted ISRO's strong culture of learning from mistakes: "ISRO gives prime importance to the process of learning from its errors," she explained, describing it as a core practice of the organization. Her career trajectory reflects both the opportunities and challenges faced by pioneering women scientists at ISRO. She began her journey in a period when female engineers were extremely few and from the outset she was entrusted with responsibilities due to her outstanding academic background. Over time, she progressed through increasingly complex projects, taking on leadership roles in mission planning, system integration, and technical oversight. During our conversation she emphasized the importance of combining technical expertise with strategic coordination, mentoring junior scientists, and cultivating collaborative networks across departments. Her career also illustrates the intersection of professional growth with personal life management. She navigated household responsibilities alongside demanding work schedules, relying on both family support and household assistance. This balance allowed her to sustain long-term engagement with complicated and strategic missions without compromising either domain. Her pride in contributing to mission successes, including designing autopilot systems, was evident. She strongly believes that scientists should be judged solely on competence, not gender, and emphasized the need for support systems for women to balance professional and personal lives effectively. She stated, "a woman cannot expect herself to do everything on her own, she should ask for help and in my case, I had family support along with household help."

Interviews with women scientists such as Ritu Karidhal, Nandini Harinath, Kalpana Kalahasti, Minal Sampat, and Moumita Dutta were drawn from secondary sources, including books, articles, and online content, as it was not possible to conduct primary interviews. These women have become icons in India's space sector, gaining recognition through missions like Mangalyaan and Chandrayaan. Ritu Karidhal recalled working late into the night after completing household duties, while Nandini Harinath spoke of managing work and helping her child study. Moumita Dutta highlighted the need for Priority, Procedures, and a Backup Plan, both at home and work. These women often had to invest extra effort at home compared to male peers yet remained driven by passion for their work. Their success, they note, was supported by strong family networks, which helped them navigate high-pressure demands in both spheres. Their accounts often reflect on their early years at ISRO, when women were few but treated as equals, highlighting both the challenges and opportunities they encountered in a predominantly male environment. Early career stages involved balancing professional duties with domestic responsibilities, requiring multitasking, strategic planning, and strong family support. As highlighted in these personal accounts of women scientists, their experiences at ISRO suggest a complex contrast between perceived equality in the workplace and broader statistical realities. While many interlocutors reported that women receive equal treatment in terms of responsibilities and recognition, data indicates that women remain underrepresented, particularly in senior leadership positions. When asked about this discrepancy, most of the respondents acknowledged the slower pace of structural change. They stated that progress is occurring over time. They described their own outlooks as largely positive, emphasizing patience and resilience as key strategies while organizational and cultural norms gradually evolve. At the same time, some of them also highlighted how extended working hours, deadlines, and demands of critical missions often impact women disproportionately. These workloads coincide with their domestic responsibilities causing a dual burden that can limit their ability to commit additional time and effort required for leadership and management roles.

Another significant factor emerging from the ethnographic analysis is the role of societal class in shaping the underrepresentation of women in the space technology sector. Most of the respondents were from middle-class urban families, often showcasing their access to high-quality education, resources, and training for competitive exams which are essential for entering the space sector. A career in space technology is highly competitive and often involves long-term training, relocation, and uncertain career paths. In conversations with women working in the sector it became clear that such demands are more easily undertaken by those from privileged backgrounds—who have the resources, familial support, and financial security to absorb these risks. Observations and interviews also reveal that the contributions of women working as technical assistants, laboratory staff, or contractual employees remain largely invisible in official narratives. Public recognition and media coverage tend to highlight the achievements of women scientists, reinforcing a perception that scientific accomplishment is synonymous with elite status. The space technology sector primarily employs engineers with backgrounds in Mechanical, Aerospace, and Aeronautical disciplines. Ethnographic observations and interviews suggest that these specializations remain highly male-dominated, which naturally limits the pool of women candidates entering the field. Women who do pursue these technical streams often report navigating classrooms and workplaces where they are visibly underrepresented, shaping both their educational experiences and early professional trajectories.

Interviews with the limited number of women respondents from space startups also provided valuable insights into the gender dynamics offering a comparative perspective with ISRO. Most of the women interviewed were young, unmarried, and early in their careers, and very few startups had women in senior leadership positions. Despite this limited representation at higher levels they reported that the work environment was generally more flexible and accommodating. Many attributed this to the less rigid organizational structures typical of startups, which allowed greater autonomy in managing tasks, work hours, and collaboration styles. This flexibility influenced both professional engagement and work-life integration. Labs and offices were open plan, encouraging spontaneous collaboration. Whiteboards and sticky notes covered walls, showing ongoing projects, deadlines, and ideas in flux. Hierarchies were not overtly visible, as founders and senior engineers frequently worked alongside other team members. Women noted that this accessibility facilitated idea-sharing, guidance-seeking, and participation in decision-making processes. As the environment was informal, adaptable and dynamic, career trajectories were often less predictable due to the small size of organizations, evolving business priorities, and limited long-term opportunities. Their interviews clearly described how organizational culture and structure shape gendered experiences within India's space ecosystem. While ISRO prioritized meritocracy within a hierarchical framework, startups emphasized agility, passion, and adaptability which seemed to have benefitted young women during their early career stages. Many ISRO facilities and space startups are in specialized industrial or research zones, often far from urban centres or residential areas. During conversations with women working at ISRO and space startups, commuting and accommodation emerged as recurring challenges shaping daily routines and career decisions. Long commutes often forced them to leave personal or family obligations unattended. It was found as physically exhausting and time-consuming. This made most of them to relocate to nearby residential zones. Even traveling for training programs or strategic mission workshops posed significant challenges for many women at ISRO. The long distances to specialized training centers, combined with domestic responsibilities and the need to manage household tasks, made frequent travelling physically and mentally consuming. Some respondents noted that these requirements sometimes limited their ability to participate fully in professional development opportunities, thereby affecting skill acquisition and potential career advancement. Such logistical challenges, while often invisible in official narratives, had a tangible impact on women's professional trajectories.

In the context of space startups, meetings, brainstorming sessions, or collaborative work often extended into late evenings, reflecting the fast-paced, agile nature of startup culture. Women reported difficulty staying late which in turn limited their ability to engage fully in discussions and decision-making processes. These observations illustrate that both in structured institutions like ISRO and dynamic space startups logistical constraints impact women's opportunities, engagement, and career growth. They highlight that beyond formal policies and merit-based structures everyday practicalities play a critical role in inclusion and professional advancement.

Transformative Role of Media

ISRO's strategic use of media has significantly amplified the visibility of its women scientists, influencing public perception and inspiring younger generations. Senior scientists, most of whom began their careers in the 1980s and 1990s, often cited traditional media—such as print journalism, television, and science fiction films like *Star Trek*—as early inspirations. For many, stories of NASA missions, articles in newspapers, and science literature helped spark their interest in space science. Some were also drawn to the cosmos through India's ancient astrological texts, while others found their path through a deep-rooted passion for STEM subjects.

"It was also the first time ISRO allowed the public to look at what was happening inside, we were on social media, we had our own Facebook page, and the world took notice," said Nandini Harinath during an interview with BBC (Pandey Geeta 2016).

While traditional media shaped earlier generations, younger scientists and students—particularly those between the ages of 20 and 30—emphasized the impact of social media in the past decade (2010–2024). All respondents acknowledged the rising role of digital platforms. Unlike traditional media, social media transcends borders and allows for real-time engagement. This was especially evident in ISRO's Chandrayaan-3 mission (2023): its YouTube channel gained over 2.35 million subscribers in just one week during the live-streamed landing, which received over 80 million views globally (ISRO 2023). Such massive engagement illustrates how social media fosters not just awareness but a deep emotional connection to national space achievements.

Focus group discussions with STEM students (aged 20–25) revealed that most relied heavily on social media for space-related updates. The accessibility of information via smartphones, coupled with real-time sharing, created a sense of involvement and pride. Students described feeling personally connected to space missions, sharing the excitement of launches and landings, and feeling as though they were part of the process. These platforms also highlighted how women balanced their demanding roles with personal responsibilities, offering relatable role models and motivating young girls to pursue STEM careers.

However, media influence is double-edged. As noted in a study (Corsbie-Massay, Wheatly 2022), media has historically reinforced stereotypes, portraying women as primarily suited for domestic roles, often deterring them from pursuing careers in science. In contrast, today's representation of ISRO women scientists challenges these norms, emphasizing competence and resilience. Female STEM students that were interviewed recognized these portrayals as motivating, though many expressed anxieties about future family responsibilities, often prioritizing work over marriage. They were also inspired by broader cultural icons such as Dr. A.P.J. Abdul Kalam, popularly known as the "Missile Man of India." He was a distinguished aerospace scientist and the 11th President of India (2002–2007). Beyond his scientific achievements, Kalam became a cultural icon and mentor figure for India's youth. His writings, speeches, and social media presence made lasting impressions among the youth. Space-themed films like *Interstellar*, *Gravity* and *Mission Mangal*—all widely consumed by the younger generation during the 2010s and early 2020s—were frequently mentioned as influential, combining entertainment with science education. Research shows that such science fiction narratives not only shape public interest but can also influence national space policies (Bingaman et al. 2022).

Current Policies

The Indian government has approved significant financial commitments to the space sector (Department of Space 2024b). Initiatives such as IN-SPACe seeks to promote the growth of space startups and strengthen economy to establish India as a global leader in space technology. As the industry expands, building a diverse and inclusive talent pool is vital. Greater participation of women and minority groups can bridge representation gaps, enhance innovation, and contribute to economic growth. Women entrepreneurs, in particular, can uplift families, reduce poverty, and promote financial independence (Coley et al. 2022). Studies highlight gender disparities in patent filing and the importance of integrating feminine perspectives into space policy (Chatterjee, Ramu 2018). In response, the Indian government has introduced several schemes through the Ministry of Science and Technology to improve gender parity in STEM fields.

Increasing women participation as innovators and entrepreneurs can cause far reaching socio-economic impacts, including improving livelihood of the families and thus reducing poverty and creating jobs (Coley et al. 2022), gain financial freedom, and reduce social exclusion, contributing to the overall economic growth of a nation. There are other studies that have analysed women's participation in innovative activities, such as patent filing, from a gender perspective (Carnett 1993;

Chatterjee, Ramu 2018; Coley et al. 2022; VanderBrug 2013). The Government of India through its Ministry of Science and Technology has enacted multiple schemes and policies to improve gender parity and promote women participation in STEM careers. The details regarding some of the major schemes have been given in Table 1.

Table 1. STEM Schemes/Fellowships for women in India

Scheme Name	Function
WISE-KIRAN – Women in Science and Engineering	• Umbrella scheme to improve women participation in STEM
STW – Science and Technology for Women	• To empower women from grassroots • Livelihood support for women using science and technology • To establish women technology parks for health, nutrition, sanitation, textile manufacturing etc.
Vigyan Jyoti Program	• To support young girls from rural regions to pursue higher education and careers in STEM
GATI – Gender Advancement for Transforming Institutions	• To inculcate gender sensitive approach and inclusiveness in institutions
SERB-POWER – Science and Engineering Research Board – Promoting Opportunities for Women in Exploratory Research	• To address lower representation of women scientists in research activities

Source: Department of Science and Technology, Govt. of India.

In addition to existing policies, initiatives such as the Pragati Scholarship (launched in 2014) and the TechSaksham Program (TSP) aim to empower women in STEM. Pragati offers financial aid to meritorious girls, while TSP enhances employability of underserved female students through hands-on, experiential learning opportunities. Women participation in STEM fields are lower than men across both high and middle-income countries (World Bank 2024). As per the report, in India the proportion of women STEM graduates is relatively higher compared to developed nations. However, their participation in some of the prestigious engineering institutions remains significantly low. Therefore, to promote gender diversity by increasing female student enrolment in the B. Tech Programmes of the prestigious technical institutes of India, like the Indian Institute of Technology (IITs) and other engineering colleges, supernumerary seats were introduced in 2018 by increasing female seats from 14% in 2019 to 20% in 2021 (Ministry of Education 2023). Figures 1 and 2 highlight gender enrolment trends at IIT Madras and the Indian Institute of Space Science and Technology.

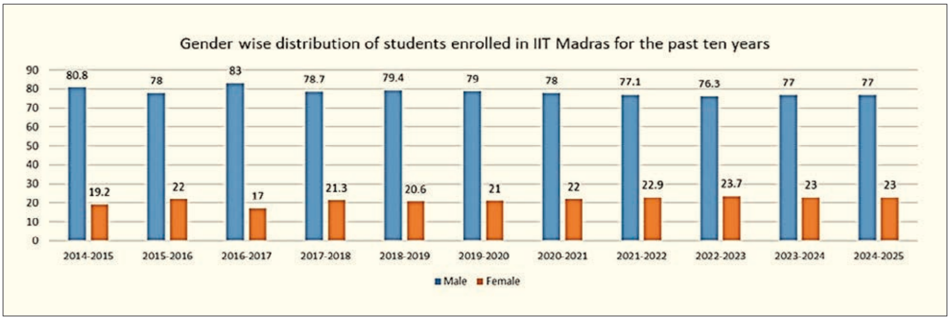

Fig. 1. Gender-wise distribution of STEM students enrolled in IIT Madras for the past ten years

Source: https://www.iitsystem.ac.in/studentstatistics.

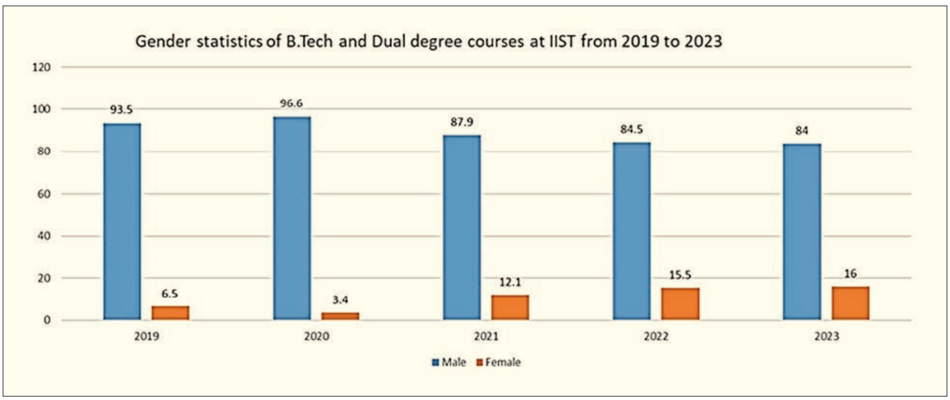

Fig. 2. Gender-wise distribution student enrolment of B. Tech and Dual Degree Courses at IIST from 2019–2023

Source: IIST Gender Audit Report 2019–2023, Govt. of India.

While female enrolment at IIT Madras rose from 17–22% to 23% post-2018, IIST's data offers key insights into women's future representation and career paths in India's space workforce. Female enrolment in space education remained low until 2020 but rose notably with policy measures like supernumerary seats, reaching 16% by 2023.

India's Economic Survey 2024–25 (Ministry of Finance 2024) also reports a sharp rise in patent filings by women—from 15 in 2015 to 5,183 in 2024. However, gender disparities persist. The Global Gender Gap Report 2024 notes women comprise only 28% of the global STEM workforce compared to 47.3% in non-STEM fields. In India, women represent just 18.6% of scientists and 25% in R&D roles, indicating continued underrepresentation, especially in leadership and high-level technical positions.

Being the pioneering space organisation in India, ISRO conducts several outreach programmes including concept/essay writing competition, painting competition, exhibitions, quizzes, awareness days etc. for youngsters. ISRO's "Space on Wheels" initiative involves mobile exhibition buses that travels to educational institutions to disseminate knowledge about ISRO's missions and includes scaled down self-explanatory models of various space technologies. ISRO also organizes a special programme for school children through its flagship programme "YUVIKA" to provide basic knowledge on space technology, space applications, and space science (Department of Space 2023). Alongside research grants and fellowships, ISRO calls for research proposals in specific areas to enhance R&D support for space projects from academia.

Future Recommendations

Drawing from the insights of this study, three key recommendations are presented to address the gender disparity in India's space sector (see Figure 3).

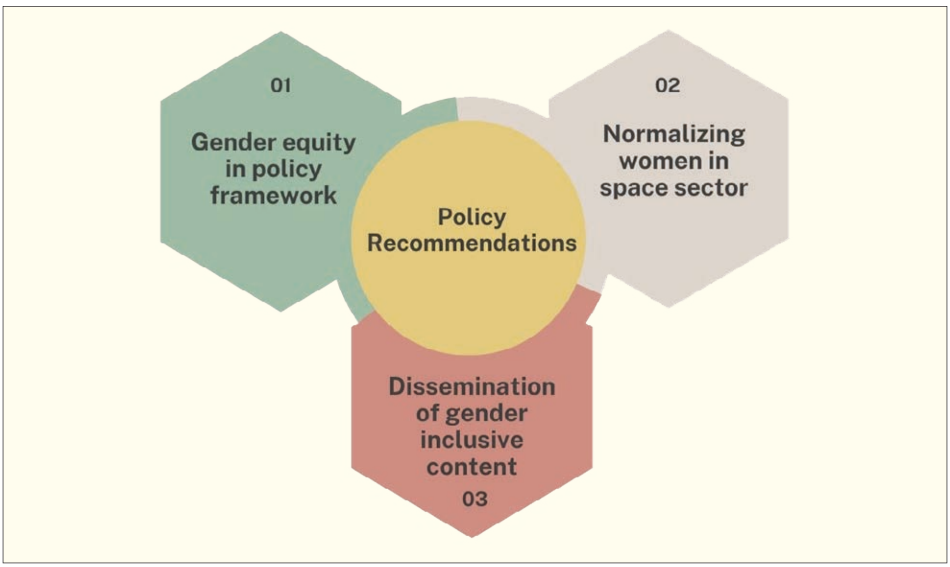

Fig. 3. Recommendations for space policy

Source: author's own work.

Gender Equity in Policy Framework

A policy document serves as an official statement outlining a government's or public authority's intentions, providing directions for practical implementation or objectives (Freeman, Maybin 2011). India's space policy 2023 acts as a regulatory framework guiding the associated stakeholders to foster a dynamic space ecosystem. Though this policy statement has been formulated to position space sector as a key economic driver, it certainly overlooks critical aspects, particularly in seeking measures to address the longstanding gender gap in the space sector. For instance, even NASA is no exception to cases of gender discrimination. However, the agency has taken a significant step by including a section recommending everyone to use non-gender specific terms while referring to space program (NASA n.d.). This means that expressions like 'piloted' and 'unpiloted' should be used instead of 'manned' and 'unmanned.' Moreover, the agency has broadened the definition of 'astronaut' to include all the crew members and not just the pilots. Another progressive step was taken by the agency by eliminating the military jet test pilot requirement from the mandatory selection qualification (NASA n.d.). This test had previously prevented many highly qualified women from becoming astronauts despite meeting all other criteria. India's space policy should take focussed steps to integrate such equitable approaches to ensure inclusive flow of expertise, which is essential in the present scenario of increasing global pursuit of space technology.

Mentorship initiatives can spark early interest in space science and help close the gender gap by exposing young girls to realistic career paths. Involving both male and female scientists in talks, workshops, and campaigns fosters inclusive networks. Encouraging male allies through targeted awareness programs is key to achieving gender equity.

As India expands its global space presence, harnessing the full potential of a diverse workforce is essential. Despite efforts to promote women in STEM, gender disparity, especially in leadership, exists. Therefore, gender-inclusive policies should be accompanied by gender-neutral measures, such as use of non-gender specific terms and language, imageries, and institutional practices etc. For instance, most of the women scientists preferred to be called as simply "scientists" than identifying them based on their gender. However, true neutrality stems from active inclusion, ensuring equal participation and representation. Achieving this requires collaboration across institutions, media, policymakers, and workspaces. Fostering such an environment will help normalize women's presence and build a more equitable and innovative space ecosystem.

Normalising Women in Space Sector

Perceptions regarding gender roles are shaped through subtle yet impactful conversations, often accepted as ordinary interactions that remain unquestioned. An analysis of interviews on social media reveals persistent gender biases. Women in STEM are frequently asked about balancing work and family, a question rarely posed to men. This reinforces the idea that women must work harder to prove themselves in male-dominated fields. While social media often celebrates women scientists to inspire others, such portrayals may unintentionally depict their success as extraordinary rather than as a reflection of their capabilities and expertise, like other male scientists. As stated previously, many women ISRO scientists emphasize that their roles, contributions, and responsibilities stand on equal footing with their male colleagues. Therefore, labelling them by gender undermines their professional identity and reinforces stereotypes. To counter this, ISRO and the government must develop focused guidelines and content that normalize women's participation in space science. Efforts should highlight contributions based on merit, not gender, promoting an inclusive narrative emphasizing their contributions without highlighting their gender.

Dissemination of Gender-inclusive Imagery

Images play a powerful role in shaping social imaginaries and influencing how individuals perceive their place in fields like space science. At an exhibition during India's first National Space Day, a banner depicting only a young boy gazing at the moon (see Figure 4) subtly reinforced gendered notions of space exploration.

Fig. 4. Banner used during an exhibition organized for celebrating India's National Space Day

Source: Photo taken by the author on August 17, 2024.

Such representations, as feminist scholar Joan Scott notes, signify “symbolic representations of gender” that associate scientific ambition with masculinity (Scott 1986). These visuals can discourage young girls from envisioning themselves in space roles, reinforcing stereotype threats. Initiatives such as inclusion of Chandrayaan-3 modules within NCERT textbooks consist of images depicting girls as space enthusiasts to promote gender-sensitive education.

However, it is not enough to simply feature them. The goal must be to normalize their presence in scientific narratives. Therefore, institutions like ISRO must carefully design outreach materials to avoid reinforcing gender stereotypes and instead promoting a more inclusive vision of space science that reflects and encourages equal participation across all sections.

Conclusions

The study highlights the need to refine India’s space policy by incorporating gender-inclusion as a fundamental section, emphasizing that scientific contributions transcend gender. Despite efforts to increase women’s participation, challenges persist. It was identified that media narratives, though promoted women scientists, often reinforced gendered perceptions by portraying their contributions as extraordinary. It was also observed that only women scientists had to face questions related to work-life balance and child rearing. In such cases, most of them stressed on working hard and depending on family members or friends during extreme cases, which can further reinforce and normalise gender roles and generate perception among youngsters that women need to work more for achieving positions in the technological fields.

Another interesting finding from the study was the transformative role of media. It was found that media influence was pervading among all sections of space scientists, including experienced and young ones. In case of older generations (aged 45 and above), print media, television, and Western films played a significant role in shaping their perspective, whereas younger individuals primarily consumed contents from social media and networking platforms which became key sources of their information and inspiration.

Drawing insights from the findings of the study, three major policy recommendations have been suggested, specifically for the space sector. Firstly, gender equity should be included as a significant part of India’s space policy, alongside initiatives that seek to commercialise and expand India’s space sector. Secondly, women’s presence and their contributions in the space sector should be normalized. Lastly, special care must be taken by the government and the space agencies to carefully design their outreach content that caters to gender-inclusive imageries. These steps will help address gender biases and foster equal participation in India’s space ecosystem.

While this study relied on publicly available sources and a limited number of interviews and focus groups, and thus cannot capture all experiences within ISRO, it provides indicative insights into the everyday dynamics, gendered practices, and media representations shaping women scientists' participation. Future research could expand these findings through broader sampling and deeper access to institutional records.

Glossary

AISHE – All-India Survey on Higher Education
ATS – American Technology Satellite
E2O – Earth to Orbit
GSAT – Geosynchronous Satellite
IN-SPACe – Indian National Space Promotion and Authorization Center
ISRO – Indian Space Research Organisation
MOM – Mars Orbiter Mission
NASA – National Aeronautics and Space Administration
NCERT – National Council of Educational Research and Training
PSLV – Polar Satellite Launch Vehicle
RISAT – Radar Imaging Satellite
SITE – Satellite Instructional Television Experiment
TES – Technology Experiment Satellite
UNDP – United Nations Development Programme
UNESCO – United Nations Educational, Scientific, and Cultural Organization
VSSC – Vikram Sarabhai Space Centre
YUVIKA – Yuva Vigyani Karyakram (Young Scientist Programme)

Acknowledgements

The author sincerely appreciates the valuable guidance and feedback provided by Dr. Anna Szolucha, Associate Professor at the Institute of Ethnology and Cultural Anthropology, Jagiellonian University, Kraków, Poland. The author also expresses sincere gratitude towards the National Science Centre, Poland, for its financial support in facilitating this research. This research would not be possible without the help and support extended by the space scientists and engineers who shared their valuable perceptions for this research. Additionally, the author acknowledges the ARIES team, including Karlijn Korpershoek, Peter Timko, and Chakad Ojani, for their insightful discussions and contributions.

Funding

This work was supported by the National Science Centre, Poland [project number 2020/38/E/HS3/00241].

References

Arrighi R.S.
2023 *Aviator Jerrie Cobb Trained in NASA's Gimbal Rig in 1960*, https://www.nasa.gov/centers-and-facilities/glenn/aviator-jerrie-cobb-trained-in-nasas-gimbal-rig--in-1960/ (accessed 29.01.25).

Bhatia B.S.
2015 *SATCOM for Development Education. The Indian Experience* in: P.V.M. Rao, B.N. Suresh, V.P. Balagangadharan (eds.), *From Fishing Hamlet to Red Planet: India's Space Journey*, New Delhi, pp. 465–475.

Bingaman J., Dawson W., Brewer P.R., Paintsil A.
2022 *Media use and US Attitudes Toward Government and Private Space Exploration*, "Space Policy", vol. 62, 101506. https://doi.org/10.1016/j.spacepol.2022.101506.

Carnett C.L.
1993 *Women's views of space law and policy: no gender-based agenda*, "Space Policy", vol. 9, pp. 329–341. https://doi.org/10.1016/0265-9646(93)90044-A.

Chatterjee C., Ramu S.
2018 *Gender and its rising role in modern Indian innovation and entrepreneurship*, "IIMB Management Review", vol. 30, issue 1, pp. 62–72. https://doi.org/10.1016/j.iimb.2017.11.006.

Coley C., Gressel C., Dhillon A., Shukla T., Sheshadri S., Pandey N., Kumar G., Bhavani R.R., Lâm Duc H.
2022 *The braided river: the universe of Indian women in science*, New Delhi.

Corsbie-Massay C.L.P., Wheatly M.G.
2022 *The role of media professionals in perpetuating and disrupting stereotypes of women in Science, Technology, Engineering and Math (STEM) fields*, "Frontiers in Communication" vol. 7. https://doi.org/10.3389/fcomm.2022.1027502.

Department of Space
2024a *Parliament Question: Efforts to Make India a Developed Nation by 2047 in Space Sector*.

2024b *Empowering India's Space Economy: Rs. 1,000 Crore Venture Capital Fund Initiative for Innovation and Growth*.

Dicks B., Soyinka B., Coffey A.
2006 *Multimodal ethnography*, "Qualitative Research", vol. 6, pp. 77–96. https://doi.org/10.1177/1468794106058876.

Elson D., Seth A. (eds.)
2019 *Gender Equality and Inclusive Growth: Economic Policies to Achieve Sustainable Development*, New York.

Freeman R., Maybin J.
2011 *Documents, practices and policy*, "Evidence and Policy", vol. 7, pp. 155–170. https://doi.org/10.1332/174426411X579207.

Gibson K.B.
2014 *Women in Space – 23 Stories of First Flights, Scientific Missions, and Gravity-Breaking Adventures*, Chicago.

Gurnani S., Sheth M.
1984 *Women scientists in India: Their position and role*, "Interdisciplinary Science Reviews", vol. 9, issue 3, pp. 259–270. https://doi.org/10.1179/isr.1984.9.3.259.

Indian National Academy of Engineering
2016 *Women Engineers in India*, vol.1, New Delhi.

Indian Space Research Organisation, Department of Space
2023 YUVIKA – YUva VIgyani KAryakram (Young Scientist Programme), https://www.isro.gov.in/YUVIKA.html (accessed 18.01.25).

ISRO
2023 *Chandrayaan-3 Mission Soft-landing LIVE Telecast*.

2024 *Annual Report 2023–24*.

ISRO Official
2023 *Chandrayaan-3 Addressing by Honorable Prime Minister-Live Event*.

Ministry of Education
2022 *All India Survey on Higher Education 2021–22*, New Delhi.

2023 *Steps taken by the Government to promote women participation in STEM Courses*, New Delhi.

Ministry of Finance
2024 *Economic Survey 2024–25*, New Delhi.

NASA
n.d. *Style Guide for NASA History Authors and Editors*.

n.d. *Become An Astronaut*, https://www.nasa.gov/humans-in-space/astronauts/become-an-astronaut/ (accessed 29.01.25).

Pal K.K., Piaget K., Zahidi S., Baller S.
2024 *Global Gender Gap 2024*, Geneva.

Pandey G.
2016 *The women scientists who took India into space* [WWW Document], BBC News.

Radhakrishnan P., Manoranjan Rao P.V.
2012 *A Brief History of Rocketry in ISRO*, New Delhi.

Scott J.W.
1986 *Gender: A Useful Category of Historical Analysis Author*, "The American Historical Review", vol. 91, pp. 1053–1075.

Singh G.
2017 *The Indian Space Programme – India's incredible journey from the Third World towards the First*, Astrotalkuk Publications, Manchester, UK.

Smith P.H., Bamberger E.T.
2021 *Gender Inclusivity is Not Gender Neutrality*, "Journal of Human Lactation" vol. 37, pp. 441–443. https://doi.org/10.1177/08903344211023358.

UNESCO
2017 *Cracking the code girls' and women's education in science, technology, engineering and mathematics (STEM).*

2024 *Global Education Monitoring Report: Gender report – Technology on her terms*.

United Nations
2015 *Transforming our world: The 2030 Agenda for Sustainable Development*.

Vaid M.
2019 *ISRO's Magnificent Women and their Flying Machines*, New Delhi.

VanderBrug J.
2013 *The Global Rise of Female Entrepreneurs*, "Harvard Business Review", https://hbr.org/2013/09/global-rise-of-female-entrepreneurs (accessed 29.01.2025).

Vice President's Secretariat
2024 *ISRO is befitting example to other organisations in promoting gender diversity – Vice-President*.

World Bank
2024 *World Development Report 2024: The Middle-Income Trap*, Washington, DC.