सत्यमेव जयते
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75 Azadi Ka Amrit Mahotsav

CAPACITY BUILDING COMMISSION

ANNUAL CAPACITY BUILDING PLAN

DEPARTMENT OF SPACE

Contents

List of Acronyms

Abbreviation	Full Form
ACBP	Annual Capacity Building Plan
AJNIFM	Arun Jaitley National Institute of Financial Management
APAR	Annual Performance Assessment Report
C&K	Content and Knowledge
CAD	Computer-aided design
CBC	Capacity Building Commission
CBPO	Capacity Building & Public Outreach
CBU	Capacity Building Unit
CCL	Center for creative leadership
CCM	Commercial & Contract Management
CFTRI	Central Food Technological Research Institute
CMM	Capability Maturity Model
CNC	Computer Numerical Control
CPPM	Certified Practicing Project Manager
CPSEs	Central Public Sector Enterprises
CSIR	Council of Scientific & Industrial Research
CSSTEAP	Centre for Space Science and Technology Education in Asia & the Pacific
CTIER	Centre For Technology, Innovation and Economic Research
DBT	Department of Biotechnology
DHR	Department of Health Research
DoAE	Department of Atomic Energy
DoP	Department of Pharmaceuticals
DoPT	Department of Personnel and Training
DoS	Department of Space
DSIR	Department of Scientific and Industrial Research
DST	Department of Science & Technology
e-HRMS	Electronic Human Resource Management System
EFC	Expected Family Contribution
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
GeM	Government e-Marketplace
GERD	Gross domestic expenditure on research and experimental development
GFR	General Financial Rules
GIS	Geographic information system
GSLV	Geosynchronous Satellite Launch Vehicle
HAL	Hindustan Aeronautics Limited
HR	Human Resource
HSFC	Human Space Flight Centre
ICAR	Indian Council of Agricultural Research
iGOT	Integrated Government Online Training
IIM	Indian Institutes of Management
IIPA	Indian Institute of Public Administration

Abbreviation	Full Form
IIRS	Indian Institute of Remote Sensing
IISER	Indian Institute of Science Education and Research
IIST	Indian Institute of Space Science and Technology
IISU	Indian Space Research Organisation Inertial Systems Unit
INSAT	Indian National Satellite system
IN-SPACe	Indian National Space Promotion and Authorization Center
IPR	Intellectual property rights
IPRC	Indian Space Research Organisation Propulsion Complex
IRS	Indian Remote Sensing
ISB	Indian School of Business
ISO	International Organisation for Standardization
ISRO	Indian Space Research Organization
ISTRAC	Indian Space Research Organisation Telemetry, Tracking and Command Network
KPI	Key Performance Indicators
LEOS	Laboratory for Electro-Optics Systems
LPSC	Liquid Propulsion Systems Centre
M&E	Monitoring and Evaluation
MoA	Ministry of Ayush
MoES	Ministry of Earth Sciences
MCF	Master Control Facility
MDO	Ministry Department and Organization
MDP	Management Development Program
MIT	Massachusetts Institute of Technology
MS	Microsoft
ML	Machine Learning
NARL	National Atmospheric Research Laboratory
NAARM	National Academy of Agricultural Research Management
NE-SAC	Northeastern-Space Applications Centre
NIC	National Informatics Centre
NNRMS	National Natural Resources Management System
NPCSCB	National Program for Civil Services Capacity Building
NPTEL	National Program on Technology Enhanced Learning
NRSC	National Remote Sensing Centre
NSIL	New Space India Limited
PCB	Printed Circuit Board
PFMS	Public Financial Management System
PG	Postgraduate
PMI	Project Management Institute
POSH	Prevention of Sexual Harassment
PRL	Physical Research Laboratory
PSLV	Polar Satellite Launch Vehicle
R&D	Research and development
RTI	Right to Information
S&T	Science and Technology

Abbreviation	Full Form
SAC	Space Applications Centre
SDGs	Sustainable Development Goals
SDSC	Satish Dhawan Space Centre
SLA	Service Level Agreements
SME	Small And Medium-Sized Enterprises
SoW	Statements of Work
SRT	Scientific Research and Training
STI-CB	Science & Technology Institutions Capacity Building
TIFR	Tata Institute of Fundamental Research
UNCTAD	United Nations Conference on Trade and Development
URSC	U R Rao Satellite Centre
VSSC	Vikram Sarabhai Space Centre
WCC	World Commerce & Contracting
WITP	Wadhwani Institute of Technology and Policy
XIME	Xavier Institute of Management and Entrepreneurship
XLRI	Xavier School of Management

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1. Introduction

1.1. Mission Karmayogi

The Government of India launched the National Program for Civil Services Capacity Building ('NPCSCB') – "Mission Karmayogi" in September 2020 to enhance governance through Civil Service Capacity Building. Mission Karmayogi comprises of six pillars as under:

- Policy framework
- Institutional framework
- Competency framework
- Digital learning framework - Integrated Government Online Training-Karmayogi platform (iGOT-Karmayogi),
- Electronic Human Resource Management System (e-HRMS), and
- Monitoring and evaluation (M&E) framework.

The institutional framework of the Mission includes

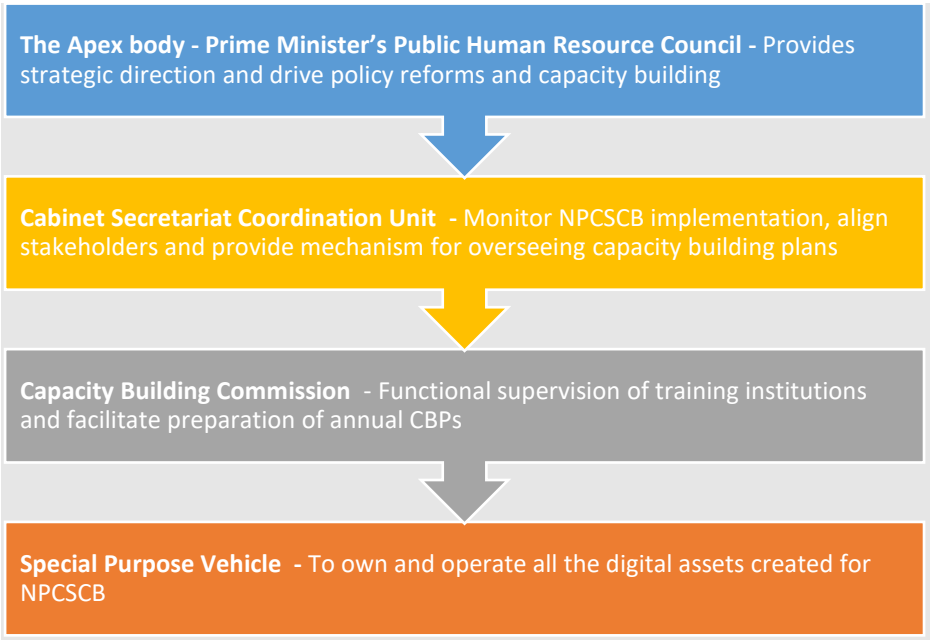


Figure 1: Institutional Framework[1]

[1] Source: Capacity Building Commission

1.2. Capacity Building Commission (CBC)

The CBC was formally constituted as an independent body in April 2021 to drive standardization and harmonization across the Indian civil services landscape. The CBC as the custodian of civil services capacity building reforms is central to the government's ambitious capacity building program. The mandate of CBC is to perform the following functions:

- Preparing an annual state of civil services report,
- Exercising functional supervision over training institutions and creating shared learning resources,
- Facilitating the creation of annual CBPs for ministries and departments,
- Organizing a global HR Summit,
- Evolving a harmonious, de-siloed approach to capacity building initiatives,
- Undertaking an audit of human resources available in government,
- Recommending policy interventions in areas of personnel/HR to DoPT, and
- Approving knowledge partners for the Mission.

1.3. The Annual Capacity Building Plan document

Taking forward the mandate of facilitating the creation of annual CBPs for ministries and departments, the CBC has been engaging and supporting multiple ministries and departments in the preparation of capacity building plans. These ministries include Ministry of Ayush (MoA), Ministry of Earth Sciences (MoES), Department of Pharmaceuticals (DoP), Department of Atomic Energy (DoAE). Department of Health Research (DHR), Department of Science & Technology (DST), Department of Scientific and Industrial Research (DSIR), Department of Biotechnology (DBT), etc.

As part of this engagement, CBC is interacting and working with these ministries to list their goals, identify their competency requirements and prepare their capacity development plans. The subsequent sections provide an overview of the vision and the goals of DoS, requirements of the various departments and key interventions proposed.

1.4. Context

This report covers key findings on aspects including organizational structure and verticals, roles & responsibilities, and division-level functioning, based on the primary and secondary research with the officials from the Department of Space, review of the department's website and various documents shared by the department. The report also covers the department's key mandate, strategic objectives and goals, key focus areas, schemes and programs and its contribution to the national priorities.

As a part of role mapping, in addition to the focus group discussion, secondary research was undertaken for each division to identify the functions to determine the right competencies for future interventions. Research on emerging trends, technologies and opportunities in the sector has been undertaken which can act as a guiding marker towards the overall goal of creating an enabling

environment for capacity enhancement and readiness of the Department of Space to take up future initiatives.

A co-development approach is being adopted for the preparation of the ACBP and inputs were sought from the leadership, particularly the Capacity Building Unit (CBU) set up by the department.

DoS is one of the departments that has undertaken the exercise of preparation of capacity building plan with CBC. Commencing the work of capacity building plan preparation, the members of CBC and Secretary, DoS along with senior officials agreed that the following activities would be taken up:

- Preparation of ACBP for Department of Space (DoS)
- Identification of training needs for both Scientific and non-Scientific staff
- Identifying institutions in India and abroad that are running courses in behavioural and functional competencies for scientists and other technical staff of the Dept of Space
- Identifying courses run at the various institutions under the Department of Space that can be utilized by other Science & Technology ministries to train their staff
- Way ahead for the Department of Space form a capacity building perspective

1.5. Current state of capacity building at the Department of Space

Department of Space has been the front-runner in the capacity building exercise and with the help of CBC, has already undertaken the following activities for the scientist staff:

- Capacity Needs Assessment of ISRO
- Competency mapping based on levels
- Demand analysis
- Competency analysis for functional and behavioural competencies
- Supply analysis
- Recommended interventions for ISRO

1.5.1. Development of annual CBP

The Annual CBP is intended to be an incremental training and capacity development system. It entails a seven-step process of enlistment and documentation of Training Needs Assessment and competency required assessment exercise for both ISRO Scientific staff, Technical/Scientific Assistants & Technicians. This exhaustive exercise has been targeted to cover institution/wing-wide roles and functions in a self-assessment exercise in ISRO. In a phased manner four identified centres at Trivandrum, Ahmedabad, Bengaluru and Sriharikota were taken up for in-person assessments with scientists. Considering the mandate of DoS, hardships faced and to identify the requirements for future capacity building, the following process has been adopted:

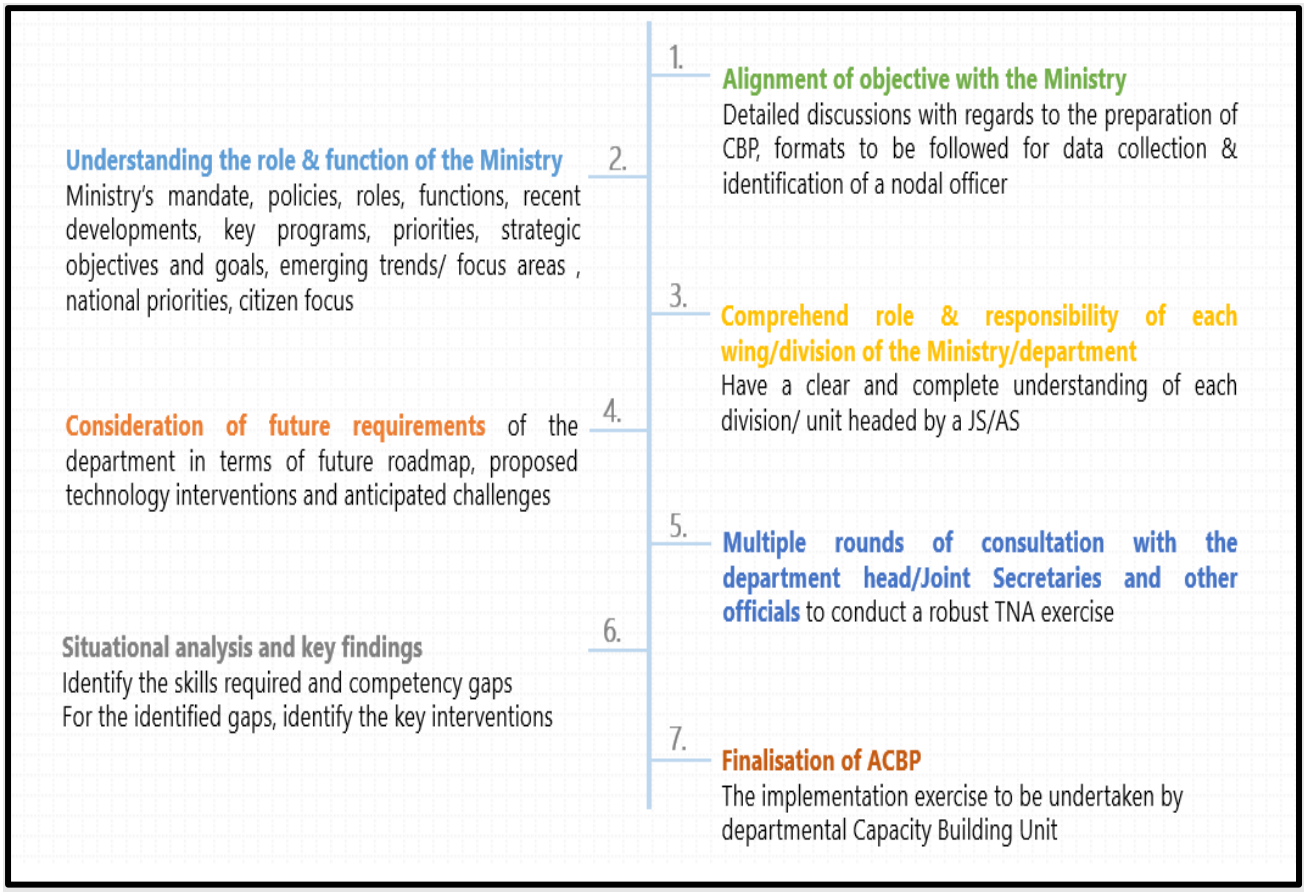


Figure 2: Stepwise development of ACBP[2]

Initially, the team performed secondary research to understand the Vision, Mission, and Goals for the identified ministries. Subsequently, discussions were held with the Secretary/ Senior Scientist/ Center Heads of all the centers. The research and discussions helped in understanding the Vision and Goals of each department within the Department and helped in assessing the role played by the Ministry in achieving its objectives. The desired competencies for each department were identified along with the current capability gaps based on the self-assessment of the Scientists level 'SC' to 'SG'. After assessing the requirements and the gaps, appropriate initiatives have been identified for strengthening the competencies.

Level of training needs have been captured to cater to acclimatization and sensitization needs of scientists entering the department, in-office needs to cater to ongoing requirements for smooth functioning, and for future readiness aspects. Level of training has been classified, to detail training needs across centers and levels, to gain or reiterate knowledge as basic, intermediate, and advanced training needs. Benchmarking exercise is limited to meeting current and future needs. As the process of capacity building is envisaged as an incremental exercise, other aspects of benchmarking remain an ongoing and continuous exercise into the future. Training's efforts are largely focused to be

[2] Source: CBPO, ISRO

delivered through online mode. However, based on varied needs and for specific requirements mixed andragogy methods have also been dovetailed into the design of training programs.

Members and Secretary, CBC along with STI-CB cell commenced the Annual CBP exercise in review meeting, outlining that instead of putting emphasis on training on administerial tasks, focus should be on imparting scientific domain skills in alignment with the mandate of the Ministry and with more futuristic training programs for functional and behavioural skills. Certain areas like time and stress management, financial management system, procedures for procurement and tender writing were identified as the highest recurring identified gaps in the various departments of the Ministry.

Training process outcome shall culminate with certification process by the collaborating institute. This entails module wise assessment for the specific aspects on which training has been obtained. These training programs shall become a crucial part of the record of competency of a scientist/officer and shall be dovetailed under the overall "Mission Karmayogi" policy necessities. These may include completion of probation upon fulfilling certification of induction exercise accomplishment, postings applicability for various roles etc. in a progressive manner. A list of competencies identified across the function and behavioural requirements across all the scientist levels is illustrated below

	Behavioural competency
Scientist/ Engineer SC	Ethics, Integrity, Self Confidence, Attention to Detail, Result Orientation, Conceptual Thinking, Desire for Knowledge, Innovative Thinking, Problem Solving, Conflict Solving, Motivation, Decision Making, Delegation, Running Effective Meetings, leading others, Planning and coordination, Negotiation skills, Accountability, Seeking Information, Communication skills, Self-Management, Commitment to the Organization, Giving Feedback.
Scientist/ Engineer SD	Strategic Thinking, Attention To Detail, Result Orientation, Problem Solving, Communication Skills, Decision Making, Negotiation Skills, Networking Skills, Team Working, Self-Management, Planning And Coordination, Conflict Resolving Strategies, Delegation, Innovative Thinking, Leading Others, Self Confidence, Taking Accountability, Desire for Knowledge, Initiative and drive, Giving feedback, Motivation, Running effective meetings, Commitment to the Organization, Organizational Awareness, Assertiveness.
Scientist/ Engineer SE	Decision Making, Attention To Detail, Problem Solving, Innovative Thinking, Team Working, Assertiveness, Planning & Coordination, Running Effective Meetings, People Management, Communication Skills, Commitment To Organization, Self Confidence, Result Orientation, Conceptual Thinking, Planning And Coordination, Self-Management, Delegation, Conflict resolving strategies, Negotiation skills, Strategic Thinking, Leading Others, Team-Working, Stakeholder Analysis & Management, Ethics, Giving feedback.

	Behavioural competency
Scientist/ Engineer SF	Decision Making, Delegation, Problem Solving, Running Effective Meetings, Ethics, Developing Others, Integrity, Leading Others, Desire For Knowledge, Self Confidence, Attention To Detail, Conflict Solving Strategies, Team Working, Networking skills, Strategic Thinking, Self-Awareness & Self-Control, Conceptual Thinking, Result Orientation, Consultation & Consensus Building, Stakeholder Analysis & Management, Giving feedback, Communication Skills, Assertiveness, Planning and coordination, Innovative thinking, Negotiation skills, Organizational awareness, People first, Initiative and drive, Seeking Information.
Scientist/ Engineer SG	Conflict Resolving Strategies, Running effective meetings, Decision Making, Strategic Thinking, Innovative Thinking, Desire For Knowledge, Leading others, Attention to detail, People First, Empathy, Accountability, Taking Accountability, Motivation, Developing Others, Giving Feedback, Result Orientation, Planning And Coordination, Assertiveness, Delegation, Integrity, Initiative And Drive, Problem Solving, Negotiation Skills, Organizational Awareness, Commitment to the Organization, Ethics, Self Confidence, Equity, Consultation and Consensus Building, Conceptual Thinking, Seeking Information, Self-awareness and control, Communication skills, Team-Working, Recruitment, Self-Management, Networking skills.

Table 1: Competency Mapping based on levels[3]

	Functional competency
Scientist/ Engineer SC	MS office, GeM, E-Office, Nic Applications, Procurement & Tendering, Science Communication, Science Diplomacy, Writing Proficiency, Team Management, Office Protocols, Data interpretation and analysis, Budgeting and accountability, Knowledge management, Project Appraisal & Management, Project Marketing
Scientist/ Engineer SD	E-office, MS office, writing proficiency, Knowledge management, Technology Management, Project Appraisal & Management, Science Communication, Team Management, Mentorship, Procurement & Tendering, GeM, NIC applications, Vendor Management, Central civil conduct code, Project Management, Writing proficiency, technical writing, Knowledge management, Quality standards, Data analysis and Interpretation
Scientist/ Engineer SE	Project Appraisal & Management, Team Management, Science Communication, Writing proficiency, Private participation, E-office, Data Analysis & Interpretation, Presentation Skills, Academic Industry Collaboration/ Research, GeM, Project Management, MS Office, Risk Analysis & Management, Procurement and tender writing, Data & Information Security, Budgeting, and accountability, IPR, Techno management, Knowledge Management, Knowledge management, PFMS, Collaboration with external stakeholders

[3] Source: CBPO, ISRO

	Functional competency
Scientist/ Engineer SF	Interfacing skills, Requirement gathering, Project Appraisal & Management, Science Diplomacy, Writing proficiency, Team Management, Techno managerial update, Technological advances, Science Communication, GeM, Private participation, MS office, Project marketing, Vendor Management, NIC applications, E-office, Office protocols, Data & Information Security, IPR, Personnel appraisal, Knowledge Management, RTI resolutions, Grammar training for cabinet note, Office order, Social Media, Organogram, National Anthem, Flag code of India and state emblem of India, Central civil conduct code, Raj Bhasha, Collaboration with external stakeholders, Procurement and Tender Writing, Budgeting and accountability, Writing proficiency, GFR, Technical writing
Scientist/ Engineer SG	Team Management, Process improvement, Science Diplomacy, Project Marketing, Science Communication, Quality Management, Technology for sighting, PFMS , Monitoring and evaluation, Strategic Thinking & Forecasting, E-Office, GeM, Writing Proficiency, Technical Documentation, Academic Industry Collaboration/ Research, Procurement and tender writing, Project appraisal and management, Budgeting and accountability, Presentation skills, GFR, Vendor Management, Organogram, Presentation skills , Collaboration with external stakeholders, Writing proficiency , Data analysis and Interpretation

Table 2: Competency Mapping based on levels[4]

1.5.2. Initial discussions

A meeting has been conducted with the CBU Head i.e., the nodal officer identified for the CBP preparation; and detailed discussions have been held with regards to the work plan, formats to be used for data collection, identification of a nodal point for day-to-day coordination, etc.

Basing the discussions, an official from the CBU Team has been requested to coordinate with various divisions in DoS for scheduling appointments with CBC representatives.

The CBU team of DoS has already conducted the survey analysis and shared the inputs & data for further proceedings. Draft ACBP was also shared

1.5.3. Meetings with the CBU Head & Officials

As a next step, detailed discussions were carried out with CBU team & inputs were captured in this ACBP draft. During the interaction, the CBU Head requested to incorporate inputs on:

a. Competencies required to undertake the work & their gaps
b. Few quick wins and suggestions on the non-training interventions

[4] Source: CBPO, ISRO

2. As-is assessment of Department to develop a Capacity Building Agenda

2.1. Overview of the DoS

The Department of Space (DOS) has the primary objective of promoting development and application of space science and technology to assist in all-round development of the nation. Towards this, DOS has evolved the following programs:

a. Launch Vehicle program having indigenous capability for launching spacecrafts.
b. INSAT Program for telecommunications, broadcasting, meteorology, development of education etc.
c. Remote Sensing Program for application of satellite imagery for various developmental purposes.
d. Research and Development in Space Sciences and Technology for serving the end of applying them for national development.
e. *Gaganyaan* Program to demonstrate human space flight capabilities
f. Satellite Navigation services through GPS Aided Geo Augmented Navigation (GAGAN), Navigation with Indian Constellation (NavIC) system
g. Capacity Building, promotion, and handholding of Non-Governmental Entities in space sector

The Department of Space is responsible for administration of the Indian space program. It manages several agencies and institutes related to space exploration and space technologies. The Indian space program under the DoS aims to promote the development and application of space science and technology for the socio-economic benefit of the country. It includes two major satellite systems, INSAT for communication, television broadcasting and meteorological services, and Indian Remote Sensing Satellites (IRS) system for resources monitoring and management. It has also developed four satellite launch vehicles Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV), Geosynchronous Launch Vehicle MK 3(LVM3) and Small Satellite Launch Vehicle (SSLV)

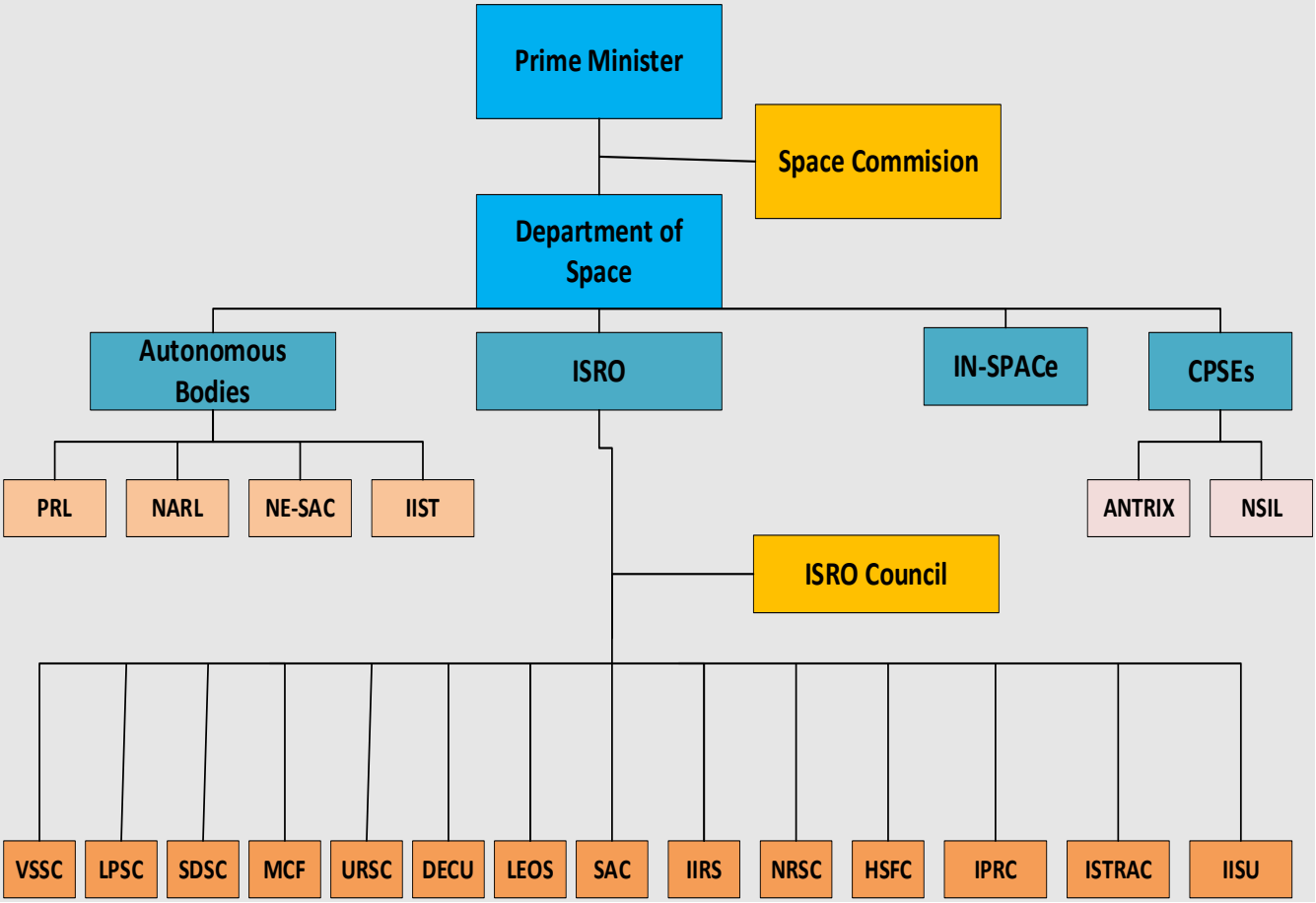


Figure 3: Organogram of DoS[5].

2.2. Overview of ISRO

The Department of Space (DOS) of the Indian government includes ISRO as a key component. The department primarily uses different ISRO Centers or Units to carry out the Indian Space Program. ISRO is one of the 6 largest space agencies in the world today and is constantly striving to provide space technology advancements for the betterment of society.

Mission
• Design and development of launch vehicles and related technologies for providing access to space. • Design and development of satellites and related technologies for earth observation, communication, navigation, meteorology, and space science.

[5] Source: CBPO, ISRO

Mission

- Communication program for meeting telecommunication, television broadcasting and developmental applications.
- Satellite-based Remote Sensing program for management of natural resources and monitoring of environment using space-based imagery.
- Space based navigation system
- Space based Applications for Societal development.
- Research and Development in space science and planetary exploration.
- Promote and authorize private firms to play key role in global Space market.
- Develop and Demonstrate Human space flight capabilities through the Gaganyaan program

Objective

- Operational flights of Polar Satellite Launch Vehicle (PSLV), Geo-synchronous Satellite Launch Vehicle (GSLV), Small Satellite Launch Vehicle (SSLV) and Geosynchronous Launch Vehicle MK 3(LVM3)
- Design and development of New Space Transportation solutions
- Design, Development and Realization of Communication Satellites
- Design, Development and Realization of Earth Observation Satellites.
- Development of Navigation Satellite Systems
- Development of satellites for Space Science and Planetary Exploration
- Earth Observation Applications
- Space based systems for Societal Applications
- Advanced Technologies and newer initiatives
- Training, Capacity building and Education
- Promotion of Space technology
- Infrastructure / Facility Development for space research
- Foster Collaboration and partnership with industry and academia, both national and international, to pursue R&D in space science technology and applications

Objective
• Commercial utilization of the products and services emanating from the Indian space program • Promotion & Authorization of Indian private firms in Space sector (through IN-SPACe)

Table 3: Mission & Objective of ISRO[6]

2.3. Existing training Institutions under ISRO/DoS

- Indian Institute of Remote Sensing (IIRS), Dehradun
- Centre for Space Science and Technology Education in Asia and the pacific (CSSTEAP)
- Physical Research Laboratory (PRL), Ahmedabad
- National Remote Sensing Centre, Hyderabad
- Space Application Centre, Ahmedabad
- Northeastern Space Applications Centre, Shillong
- UR Rao Satellite Centre (URSC), Bengaluru
- Indian Institute of Space Science and Technology, Trivandrum

2.3.1. Courses Offered in the Institutions

The various training institutes have been mentioned below. These courses re offered to students, graduates, postgraduates, government officials and private sector as well. Some of the training programs are also available for international students. These include-

- PG Diploma – 9 Specializations (10 months)
- PG Diploma – Geoinformatics conducted in collaboration with the Faculty of Geo-information Science & Earth Observation of the University of Twente, The Netherlands.
- Graduate, Postgraduate and research courses from IIST

Other courses have been detailed below

#	Course Title	Org	Mode of training	Duration (Hours)	Enrollment Fee	Link
1	Remote Sensing with special emphasis on Digital Image Processing	IIRS	Offline	8 weeks	Sponsored by ITEC/ MEA	https://admissions.iirs.gov.in/documents/SRS_ITEC_Flyer.pdf
2	Short Course on Geoinformatics	IIRS	Offline	9 weeks	Sponsored by ITEC/ MEA	https://admissions.iirs.gov.in/documents/SGI__ITEC_Flyer.pdf

[6] Source: isro.gov.in

#	Course Title	Org	Mode of training	Duration (Hours)	Enrollment Fee	Link
3	Image Statistics	IIRS	Online	5	Free	https://www.iirs.gov.in/about-iirs-outreach-program
4	Basic Remote Sensing	IIRS	Online	22	Free	https://www.iirs.gov.in/about-iirs-outreach-program
5	Photogrammetry and Cartography	IIRS	Online	14	Free	https://www.iirs.gov.in/about-iirs-outreach-program
6	Digital Image Processing	IIRS	Online	21	Free	https://www.iirs.gov.in/about-iirs-outreach-program
7	Geographical Information System	IIRS	Online	26	Free	https://www.iirs.gov.in/about-iirs-outreach-program
8	Global Navigation Satellite System	IIRS	Online	6	Free	https://www.iirs.gov.in/about-iirs-outreach-program
9	Customization of Geospatial Tools	IIRS	Online	8	Free	https://www.iirs.gov.in/about-iirs-outreach-program
10	Applications of Geospatial Technologies-Theory	IIRS	Online	4	Free	https://www.iirs.gov.in/about-iirs-outreach-program
11	Bhuvan Overview Training	NRSC	Webinar		Free	https://www.nrsc.gov.in/Courses_Overview?language_content_entity=en
12	Hyperspectral Remote Sensing	NRSC	Offline	5 days	4800	https://www.nrsc.gov.in/sites/default/files/pdf/training/Hyperspectral_course_brochure_2023.pdf
13	Microwave Remote Sensing Applications	NRSC	Online	5 Days	4800	https://www.nrsc.gov.in/sites/default/files/pdf/training/Microwave_brochure_2023.pdf
14	Geospatial Technologies and Applications	NRSC		12 weeks		https://www.nrsc.gov.in/Courses_Regular
15	Remote Sensing Applications for Land	NRSC		2 weeks		https://www.nrsc.gov.in/Courses_ThemeSpecific/

#	Course Title	Org	Mode of training	Duration (Hours)	Enrollment Fee	Link
	Resources Management					
16	Geospatial Technologies for Climate Studies	NRSC		2 weeks		https://www.nrsc.gov.in/Courses_ThemeSpecific/
17	Open Source GIS	NRSC		2 weeks		https://www.nrsc.gov.in/Courses_Special
18	Overview of Geospatial Technologies	NRSC		1 week		https://www.nrsc.gov.in/Courses_Special
19	Bhuvan Overview	NRSC		3 days		https://www.nrsc.gov.in/Courses_Special
20	Space Enabled Geoinformation for Disaster Management	NRSC		1 week		https://www.nrsc.gov.in/sites/default/files/doc_to_html/Courses-2020.pdf
21	Hydrologic Modelling using Geospatial Data Inputs for Water Resources Management	NRSC		2 weeks		https://www.nrsc.gov.in/sites/default/files/doc_to_html/Courses-2020.pdf
22	Planetary Science	PRL		5 days		https://www.prl.res.in/prl-eng/un_school_short_course
23	Solar Physics	PRL		6 days		https://www.prl.res.in/prl-eng/un_school_short_course
24	Satellite Communications (SATCOM)	SAC & CSSTEP	Offline	Not mentioned	Paid	https://www.cssteap.org/satellite-communications-details
25	Satellite Meteorology and Global Climate (SATMET)	SAC & CSSTEP	Offline	Not mentioned	Paid	https://www.cssteap.org/satellite-meteorology-global-climate-courses-details
26	Space and Atmospheric Sciences	PRL & CSSTEP	Offline	Not mentioned	Paid	https://www.cssteap.org/space-atmospheric-science-courses-details

#	Course Title	Org	Mode of training	Duration (Hours)	Enrollment Fee	Link
27	Global Navigation Satellite Systems	SAC & CSSTEP	Offline	Not mentioned	Paid	https://www.cssteap.org/global-navigation-satellite-systems
28	UNNATI (UNispace Nanosatellite Assembly & Training by ISRO)	URSC	Offline	Total duration of eight weeks and for a batch of thirty (30) participant	Paid	https://www.ursc.gov.in/indounssp/UNNATI_batch3_brochure.pdf
29	Young Scientist Programme (YUVIKA)	CBPO	Offline	2 weeks (350 students)	Free	https://www.isro.gov.in/YUVIKA.html

2.4. Staff Strength

ISRO has 20 centers across India with a total capacity of around 16079 staff members at present. Most of the scientific personnel are concentrated in 4 centers namely:

- Vikram Sarabhai Space Centre, Thiruvananthapuram
- U R Rao Satellite Centre (URSC), Bengaluru
- Satish Dhawan Space Centre, Sriharikota
- Space Applications Centre, Ahmedabad

The details of staff working in the Centre/Units against the sanctioned strength are:

S.no	Center Name	No. of Staff
1	Vikram Sarabhai Space Centre Thiruvananthapuram	4583
2	U R Rao Satellite Centre (URSC), Bengaluru	2489
3	Satish Dhawan Space Centre, Sriharikota	2115
4	Space Applications Centre, Ahmedabad	1989
5	Liquid Propulsion Systems Centre, Trivandrum	1300
6	National Remote Sensing Centre, Hyderabad	827
7	ISRO Propulsion Complex, Mahendragiri	643
8	DOS/ISRO HQ	400
9	ISRO Telemetry, Tracking and Command Network, Bengaluru	426
10	Master Control Facility, Hassan	290
11	Physical Research Laboratory, Ahmedabad	270
12	Advanced Data Processing Research Institute, Secunderabad	154
13	Human Space Flight Centre, Bengaluru	213
14	Indian Institute of Space Science and Technology, Trivandrum	98
15	Indian Institute of Remote Sensing, Dehradun	110
16	National Atmospheric Research Laboratory, Tirupati	70
17	North-Eastern Space Applications Centre, Meghalaya	54
18	ANTRIX	16
19	New Space India Limited, Bengaluru	11
20	IN-SPACe	21
	Total	**16079**

Table 4: Details of Strength of staff[7]

2.5. Capacity Building vision of DoS

Capacity building would allow the scientific departments to keep pace with the rapidly changing landscape of the sector the department operates in and for its employees to evolve tech usage in the workspace. Capacity building exercises will be necessary to nurture capable scientific minds for the

[7] Available at https://www.isro.gov.in/media_isro/pdf/AnnualReport/Annual_Report_2022_23_Eng.pdf

rapidly evolving science and technology scenarios in the nation. The scientific departments contribute to the national goals through three key outcomes:

2.5.1. Driving research excellence

Scientific departments carry out fundamental and advanced research, the research outcomes are useful to push the boundaries of knowledge from basic sciences to advanced technological solutions. To compete on the global fronts though calls for improvement in the outcomes on:

a. Volume and quality of scientific outputs
b. Outputs relative to expenditure
c. Development of new research networks
d. Availability of research skills
e. Improved use of research infrastructure

2.5.2. Enabling Institution-Industry Collaborations & Technology Transfer

The scientific departments of government generate technologies with potential use cases in industry and other government departments. E.g., Research on dehydrated food from CFTRI is used by the Ministry of Defence to make food packs for soldiers in tough areas and by industry to produce Ready-To-Eat foods in market. The deployment and commercialization of technologies can be supported by improvement in the outcomes on:

a. Intellectual property regulation
b. Employment regulations on research commercialization
c. Technology transfer offices
d. Design and execution of programs to support science-industry collaboration

2.5.3. Supporting growth of Business Innovations

The translation of research to market, banks heavily on the support systems such as Incubators, venture funding and innovation procurements. The Indian private sector presently contributes only 37% in overall GERD spending in the nation and there is a tremendous potential for growth. The growth of the private sector would have to be supported by an enabling environment to ensure that research from the government labs reaches the market. Additionally, the Government itself procures innovations to effectively deliver services, hence increasing business innovations has two-fold benefits and can be driven through:

a. Access to finance: funding, grants, and debts
b. Innovation supportive regulations: Tax incentives and trade regulations
c. Supportive innovation ecosystem: Mentors and Incubators
d. Technology extension services
e. Standards and technical regulations

Based on a broad responsibility and competency mapping, followed by a preliminary systemic and institutional assessment through discussions with heads of different divisions/wings, an indicative

strategic vision and direction of the capacity building initiative specific to DoS has been developed as below:

Activity	Details
Vision	Harness, sustain and augment space technology for national development, while pursuing space science research and planetary exploration
Technology centric goals	Leverage technology in the areas of • Science and Technology • Space Applications • Digitization for efficiencies & effectiveness
Citizen-centric goals	• Establish and maintain national space infrastructure for telecommunication, broadcasting and navigation needs of the country • Provide satellite service including imagery for weather forecasting, disaster management, natural resources survey and monitoring of the environment • Provide its products and services in a prompt, efficient and transparent manner to all the users/clients • Promote and authorize private firms to play their role in Space sector, globally • Provide satellite imagery required for the developmental and security needs of the country. • Provide satellite imagery and specific products and services required for application of space science and technology for developmental purposes to the Central Government, State Governments, Quasi-Governmental Organizations, NGOs, and the private sector. • Provide launch services, satellite, or sub-systems, launch support, mission support, ground system support and disaster management • Promote Research & Development in space sciences and technology.

Table 5: Capacity Building of DoS[8]

[8] Source: CBPO, ISRO, PwC Analysis

2.6. Current capacity building initiatives at ISRO

ISRO undertakes various capacity-building activities like advanced technology developments towards indigenization, human resource development through various training programs, collaborative research with academia, industry and research institutes, technical facility & infrastructure development, and MoU with government entities & other reputed institutes for sharing technology know-how.

2.6.1. Technology transfer and Intellectual Property Rights

ISRO has transferred more than 363 technologies to around 250 industries across India. As per the recent Cabinet approval responsibility of transferring technology to industries lies with NSIL (the commercial arm of DOS). Accordingly, ISRO has entered into an MOU with NSIL for the transfer of ISRO's technologies. Further, ISRO has transferred around 78 technologies to M/s NSIL for transferring to Indian Industries for commercialization, societal application, and regular production. Based on the market potential and industry demand, NSIL is transferring these technologies to industries through an MoU. ISRO has compiled the Interest Exploration Notes [IENs] of more than 165 active technologies available across ISRO centers and published on the ISRO website.

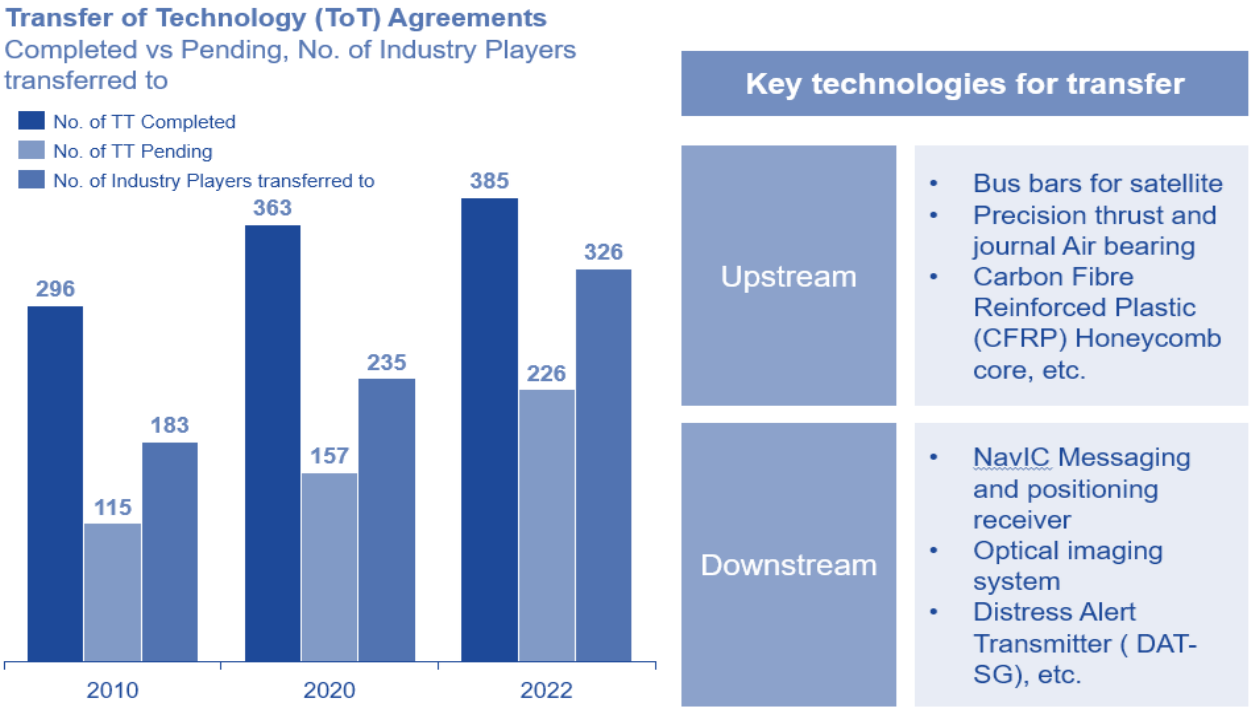


Figure 4. ToT agreements and key technologies for transfer by ISRO

ISRO has 223 active patents, 73 copyrights, and 13 trademarks. During the year 2022-23, 21 patent applications and 3 copyright applications are filed, 43 fresh patents were granted, and active patents were renewed. Presently, 87 patent applications are under various stages of examination, and 21 are undergoing drafting by the patent attorneys before their eventual filing

at the patent office. Internationally, one PCT application has been granted. A new IPR portal has been developed to process the IPR proposal from ISRO centers online and also ISRO's active IPRs have been updated and made available on the ISRO website[9]

2.6.2. Student Outreach Programs

2.6.2.1. Young Scientist Program (YUVIKA)

The YUVIKA was an offline residential training program conducted from second and third week of May, every year. Around 350 students from 36 States/UTs across the country were trained in the space domain at 7 centers of ISRO viz, VSSC, Thiruvananthapuram, URSC, Bengaluru, SAC, Ahmedabad, NRSC, Hyderabad, SDSC, Sriharikota, IIRS, Dehradun and NE-SAC, Shillong. The program includes teaching theory as well as practical demonstrations of scientific concepts, interaction with eminent scientists, lab/facility visits, sky gazing, robotic activities, and some co-curricular activities. Around 1 lakh students applied for the program online, out of which 152 students were selected based on their academic scores, online quiz, and achievements in other co-curricular activities.

2.6.2.2. Space Tutor Program

Space Tutor is a student outreach program, which connects students, academia, space enthusiast, etc., with ISRO through NGEs/startups/Institutions. It will enable promotion space education & STEM activities across the student community. 56 NGEs/ Institutions/Startups from different states of the country have registered with ISRO to promote the space education nook & corner of the country.

2.6.2.3. ISRO's virtual space museum: SPARK

ISRO developed a virtual space museum with digital content pertaining to various ISRO missions in an interactive manner. The virtual space museum "SPARK" was launched by Secretary, DOS / Chairman, ISRO on September 10, 2022, for public use. The platform hosts several documents, images & videos related to ISRO launch vehicles, satellites, and scientific missions.

2.6.2.4. Antriksh Jigyasa portal

ISRO developed a Antriksh Jigyasa online portal to provide e-learning on space science, space technology, and space applications. Secretary, DOS / Chairman, ISRO has launched the portal on November 14, 2022, for public access. Major components of Antriksh Jigyasa are Shiksha Gagan, Space Varta, Skypicks, Antriksh Navachar, Space Quiz, etc.

2.6.2.5. National Conference and exhibition on Akash Tattva

ISRO took a lead role in organizing a national conference & exhibition on "AKASH TATTVA" along with 6 S&T Ministries/Departments. The event was hosted by ISRO at IIRS, Dehradun. It is the first in a series of "Panchamahabhoot" conferences being planned this year as part of the "Sumangalam" campaign. The "Akash for life" national conference was organized from November 5-7. Dr. Jitendra Singh, MoS, inaugurated the conference in the presence of the Secretary, DOS / Chairman, ISRO, Chief Minister of Uttarakhand, and secretaries of S&T Ministers / Departments.

[9] Available at https://www.isro.gov.in/media_isro/pdf/AnnualReport/Annual_Report_2022_23_Eng.pdf

2.6.3. Human Resource Development

2.6.3.1. ISRO Technical Training Program (ITTP)

ISRO signed an MoU with the Ministry of Skill Development & Entrepreneurship (MSDE) on April 27, 2022, for organizing ISRO Technical Training Program (ITTP). The program is intended to impart skill development training to the technical staff of ISRO at various technical facilities of National Skill Trainings Institutes (NSTIs) across the country under MSDE. The MoU was signed by Secretary DoS / Chairman ISRO and Secretary MSDE. Based on the MoU, ISRO has signed an agreement with six NSTIs, viz. NSTI Bengaluru, NSTI Chennai, NSTI – Mumbai, NSTI – Thiruvananthapuram, NSTI –Ramanthapur, Hyderabad, and NSTI – Vidyanagar, Hyderabad. A total of 21 ITTP programs have been conducted at five NSTIs by imparting training to 500 Technical staff from various ISRO Centers during FY 2022-23.

2.6.3.2. Management Development Program (MDP)

Capacity Building Commission (CBC), in association with STI-CB cell, PSA's office & ISRO, has launched a Leadership Training Program for 32 scientists from 8 science ministries. The training program was organized from September 27-30, 2022. ISRO has taken the lead in hosting the program. The CBPO team, along with CBC team, visited major ISRO centers and interacted with various levels of scientists to obtain the training domains for preparing the Annual Capacity Building Plan.

2.6.3.3. RESPOND (Sponsored Research) Program

Academic Interface is one of the most important activities of CBPO. Capacity Building and Public Outreach [CBPO] office at ISRO Headquarters, aims at encouraging joint collaborative and participative research with academia/ Labs/ institutes and establishing the Knowledge/incubation/research etc. Centers across the country. Recognizing the need for a broader academic interface with institutions across the country, a series of capacity-building initiatives have been taken up to further strengthen the involvement of academia for ISRO programs. These initiatives include R&D Projects (RESPOND Basket); Space Technology Cells (STCs); Regional Academic Centers for Space (RAC-S); Space Technology Incubation Centers (S-TICs); Centre of Excellence (CoE) at IISc; Satish Dhawan Centre for Space Science (SDCSS) at the Central University of Jammu; collaboration with Centre for Nano Science & Engineering (CeNSE) at IISc and ISRO Chairs.

2.6.3.3.1. Sponsored Research

ISRO started the RESPOND (Sponsored Research) program in the 1970s with the objective of encouraging academia to participate and contribute to various Space related research activities. Under RESPOND, projects are taken up by the faculty of Universities/Academic Institutions in the areas of relevance to the Space Program. Under this program, financial and technical support is provided to academia in India for conducting research and development activities related to Space Science, Space Technology and Space Applications. RESPOND program aims to enhance the academic base and generate quality human resources and infrastructure at the academic institutes to support the Indian Space program. The research studies are expected to be directed towards some of the future Space activities, which would be a good supplement to various missions undertaken by ISRO.

2.6.3.3.2. Setting up of Space Technology Cells

ISRO has also set up nine Space Technology Cells (STC) at premier institutions like the Indian Institute of Technology (IITs) - Bombay, Kanpur, Kharagpur, Madras, Guwahati, Roorkee, and Delhi; Indian Institute of Science (IISc), Bengaluru and Joint Research Program with Savitribai Phule Pune University (SPPU, Pune) to carry out research activities in the areas of space technology and applications.

2.6.3.3.3. Setting up of Regional Academic Centers for Space (RAC-S)

With an aim to pursue advanced research in the areas of relevance to the future technological and programmatic needs of the Indian Space Program and act as a facilitator for the promotion of space technology activities among students in the region, ISRO has set up 6 Regional Academic Centre for Space (RAC-S) in the country. These 6 (RAC-S) have been established at MNIT, Jaipur (Western region), Gauhati University, Guwahati (North-Eastern Region), NIT Kurukshetra (Northern Region), NITK Surathkal (Southern Region), IIT(BHU) Varanasi (Central Region) and NIT Patna (Eastern Region). These RAC-s are inculcating the scientific temperament in the student community and also providing them with an opportunity to work in the advanced fields of research. RAC-S also facilitates and engages other institutes of excellence in the region to take part in capacity building, awareness creation, and research & development activities. ISRO has also setup Veer Surendra Sai Space Innovation Centre at Veer Surendra Sai University of Technology (VSSUT), Birla, Odisha,

2.6.3.3.4. Other Initiatives

The collaboration with the Centre for Nano Science and Engineering (CeNSE) at IISc caters to the requirements of ISRO in the areas of nanotechnology and nanoscience. The Centre is providing support for the R & D activities, utilization of nanofabrication and characterization facilities by the various centers of ISRO, in addition to training/ capacity building. With an aim to pursue advanced research in the areas of materials, especially on nonclassical continuum mechanics and Geometric and data-driven models for space applications Centre of Excellence (CoE) on “Advanced Mechanics of Materials” has been set up at IISc. In order to cater to the emerging Geospatial and Space technology requirements for the development of the region, Satish Dhawan Centre for Space Science” has been established at the Central University of Jammu, Jammu. Research and development related to space science, space-based disaster management, technologies for the development of the region etc., is the prime importance at the center. Also, under RESPOND, support is provided towards national/ international conferences focused on space activities or connected to the ISRO’s missions/ programs/ objectives, which are conducted by recognized universities/ Institutions/ Agencies / Industries on the themes of mutual interest.

2.6.3.3.5. Activities

During the period, RESPOND supported 26 New Projects, 43 ongoing projects, R & D activities of nine Space Technology Cells, and six Regional Academic Centre for Space. During the year, 34 sponsored projects have been successfully completed. Scientific publications have emerged out of these projects apart from fulfilling the objectives. During the year, 33 Universities/Colleges, 16 IITs /NITs, and 8 Research Institutes/ Laboratories were involved in R & D projects. Further, during the year, a large number of projects have been supported in the area of Space Technology (43) followed by Space Applications (22) and Space Science (14).

2.6.3.3.6. Completed RESPOND projects (non-exhaustive)

RESPOND has supported 26 new projects and 43 ongoing projects pertaining to nine Space Technology Cells in 2022-23. Under STCs, 34 projects have been successfully completed during the year. The projects are reviewed by domain experts in ISRO and later by Joint Policy Management Committees consisting of experts from ISRO and the academia. Some of these projects are:

- Speech technologies for humanoid
- Development of High Entropy alloy wear resistance coating
- Ion Source Facility for Calibration of Ion Mass and Energy Analyzers for Space Missions
- Oxygen reduction reaction catalyst development for fuel cells using in situ Spectroscopy
- Numerical study of flow thermal response of a high-speed vehicle with ablative /non-ablative thermal protection system.
- Radiative Impact of Clouds: Assessment of the Intra-seasonal and Interannual variability during Indian Summer Monsoon Season
- Development of Rotocraft UAV for Operation in Martian Atmosphere
- Computational modelling and analysis of damage in high-strength composite structures by novel non-local approach
- Theoretical and experimental studies on flow characteristics during the source switch over for feeding propellants in the liquid rocket engine test facilities.
- Development of High Entropy Alloy Wear Resistance Coating

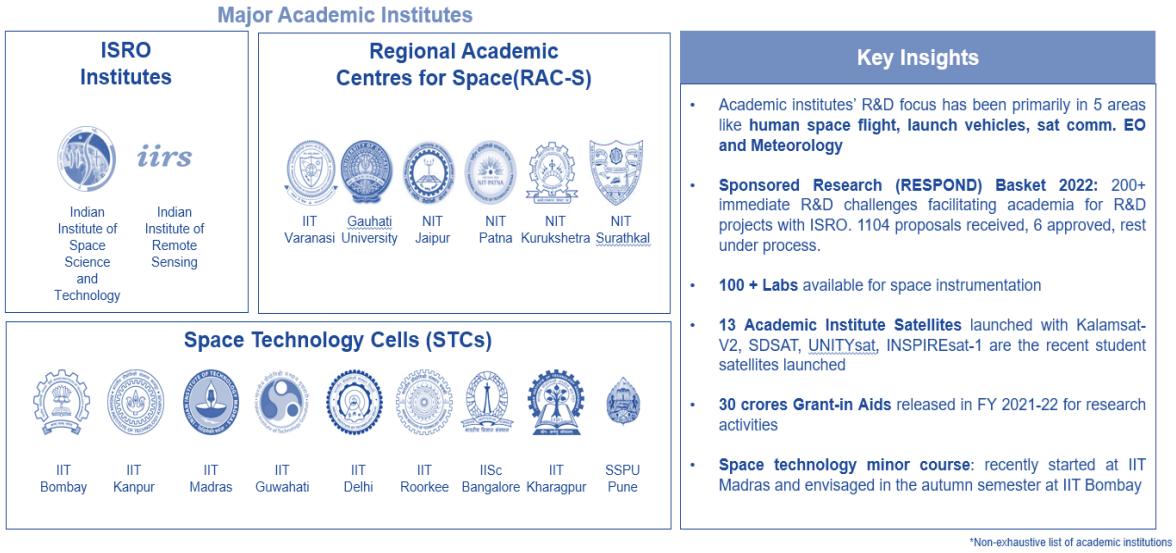


Figure 5. Key highlights of the RESPOND program

2.6.3.4. I-Grasp Online Portal

ISRO has also launched "I-GRASP" online portal (ISRO Grant in Aid for Space Research Program). The portal invites proposals from academia online and processes them online. The PIs from the academic institutions, based on their area of interest and expertise, select, and submit the research proposals through this portal. Further, the entire process of evaluation and approval is also carried out through this portal. The portal supports the submission of proposals under RESPOND/Space Technology Cells (STC)/ Space Technology Incubation Centers (S-TIC) and Other Grant in Aid programs. During the current year, against 195 research problems projected under RESPOND Basket, around 1120 proposals have been received online through the I-Grasp Portal.

2.6.3.5. Space Technology Incubation Centers

Space Technology Incubation Centre (S-TIC) is an initiative to attract and nurture young academia with innovative ideas/research aptitude for carrying out research, motivating and encouraging them to initiate startups and businesses in the field of space technology & applications and developing the Academia–Industry ecosystem for Space Technology. At present, six S-TIC are functioning, one each, at six regions of the country viz. at NIT Agartala (Northeastern zone), NIT Jalandhar (North zone), NIT Tiruchirappalli (South zone), MANIT, Bhopal (Central zone), VNIT, Nagpur (Western zone) and NIT Rourkela (Eastern zone). 3 Projects have been completed at these S-TICs, and 42 projects are in progress. During2022, S-TIC have created a remarkable impact by providing hands-on expertise to more than 350 students of various engineering/science disciplines for state-of-the art technical incubation and product development activities related to Space Science and Technology

2.6.4. Technology Development Programme

Technology Development (TD) Programme of DST10 supports activities aimed at developing and integrating technologies to evolve materials/process/techniques both in the

[10] Available at https://dst.gov.in/technology-development-program-tdp

advanced/emerging areas and in traditional sectors/areas. Under the Programme, feasibility of fresh ideas/ concepts is assessed for their potential conversion into useful technology/product. Applications of R&D for socio-economic benefits is consciously promoted under this programme.

Several ISRO centers including IIST, IIRS, SAC etc. have significantly contributed to the research activity through the TDP. In 2018, The Robust Technology Development Programme of SAC, ISRO had developed an innovative satellite payload using the concept of origami, the art of paper folding[11].

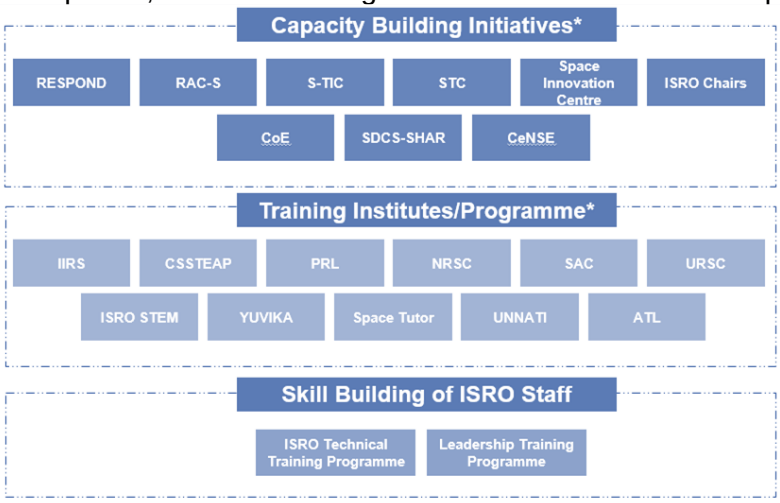
[11] Available at https://www.deccanchronicle.com/science/science/270318/isro-tests-ultra-high-tech-camera.html

3. Baselining and Benchmarking

3.1. Baseline

3.1.1. Capacity Building Initiatives

ISRO undertakes various capacity-building activities like advanced technology developments towards indigenization, human resource development through various training programs, collaborative research with academia, industry and research institutes, technical facility & infrastructure development, and MoU with government entities & other reputed institutes for sharing technology.

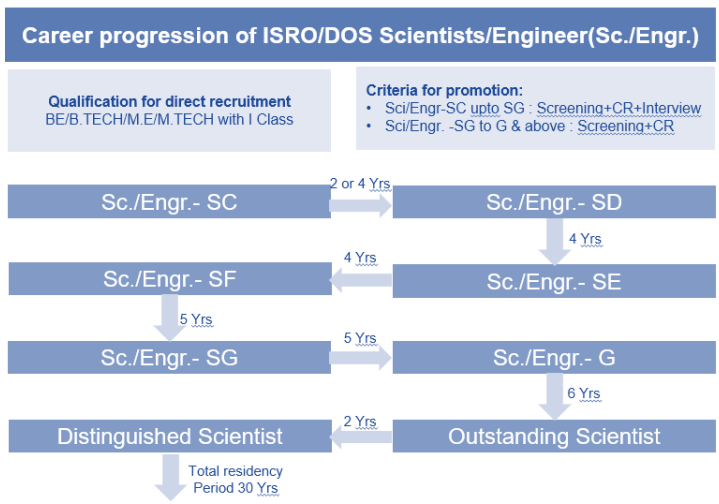


Key Insights

- **Ongoing Projects** as under Capacity Building **216-RESPOND,13-RAC-s,174-STCs**
- **NRSC:** 20 programmes and training **around 500 officials / academic scholars per year** in various applications
- **YUVIKA-2022:153 nos. of students from 36 states/UTs** participated in the programme in the year 2022
- **UNNATI:60 participants from 33 countries** in two batches and third batch training is in progress
- **Skill Building of ISRO Staff: 4000** ISRO technical staff to be trained over **next 5 years and 32 Scientists from 8 science ministries**

Figure 6. Capacity building initiatives at ISRO

Typical promotion cycle for Scientists/Engineers is 4 years, with a ratio of 3:1 for scientific vs administrative staff



Key Insights

- **86 students** from the batch of 2017- 2021 of B.Tech/Dual Degree at **IIST are inducted into ISRO/DOS**
- **Live register Scheme:** Foreign PG degree or PhD holders specialized in the interest areas of Indian Space programme after review of their respective candidature are absorbed after into ISRO, **281 candidates** have been given this opportunity till date
- The ratio of **Scientific Staff vs Administrative** staff is **3:1**
- Scientists and Technical Staff: **Male to Female ratio- 5:1**
- Administrative Staff : **Male to Female ratio: 2:1**

Figure 7. Career progression of Scientists/Engineers in ISRO

3.1.2. R&D Focus for the next ten years

For the forthcoming ten years, ISRO's focus is on emerging technologies and a majority of the R&D effort is likely to be in the upstream technologies including stage recovery and reuse, LoX Methane engine< miniaturization, air breathing propulsion, advanced energy systems and electric propulsion, etc. The capacity building plan for the DoS will also need to focus on domain specific trainings in these areas for the scientists/engineers. It is also seen that significant R&D happens as part of the space programs. In the midstream segment, focus will be on inter-linking of satellite networks and quantum communication, while in the downstream segment it will be on advanced data processing techniques, Space bio-metrics, Artificial Intelligence, and resource utilization.

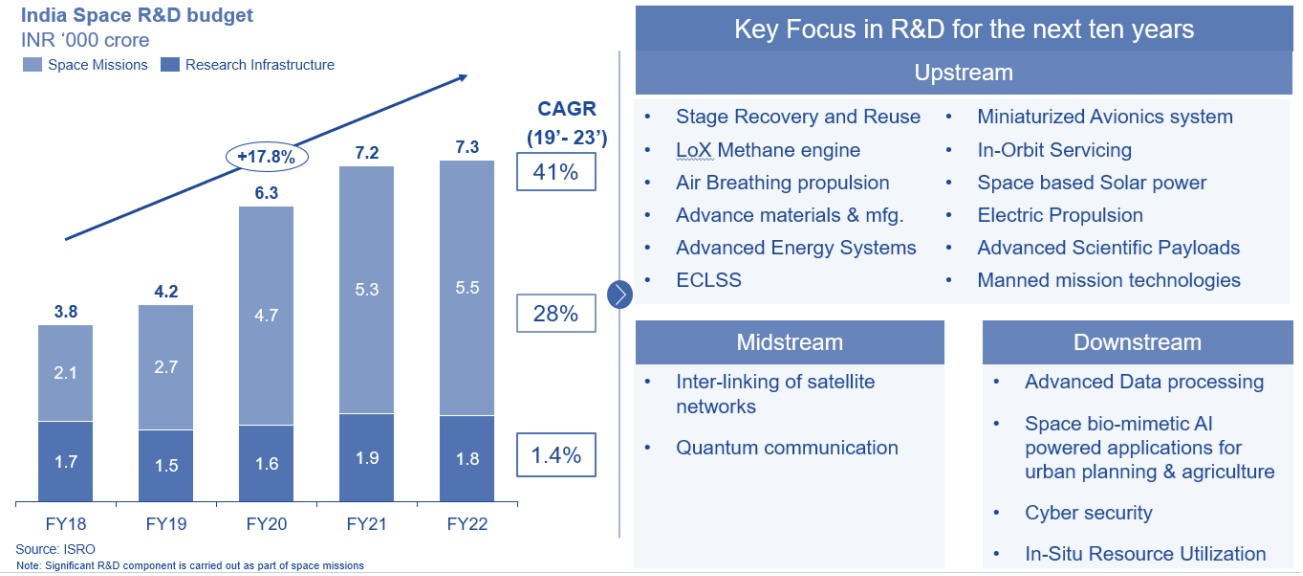


Figure 8. R&D focus in emerging technologies for the next ten years

3.1.3. Intellectual Property Rights (IPRs)

ISRO has 223 active patents, 73 copyrights, and 13 trademarks. During the year 2022-23, 21 patent applications and 3 copyright applications are filed, 43 fresh patents were granted, and active patents were renewed. Presently, 87 patent applications are under various stages of examination, and 21 are undergoing drafting by the patent attorneys before their eventual filing at the patent office. Internationally, one PCT application has been granted. A new IPR portal has been developed to process the IPR proposal from ISRO centers online and also ISRO's active IPRs have been updated and made available on the ISRO website.

The number of patents filed each year has been consistently growing and has registered a growth of nearly 43% over the last five years. This indicates a steadfast approach towards capacity building and also assists in identifying competency needs for the scientists/engineers and the domain specialization requirements of the technical staff/assistants.

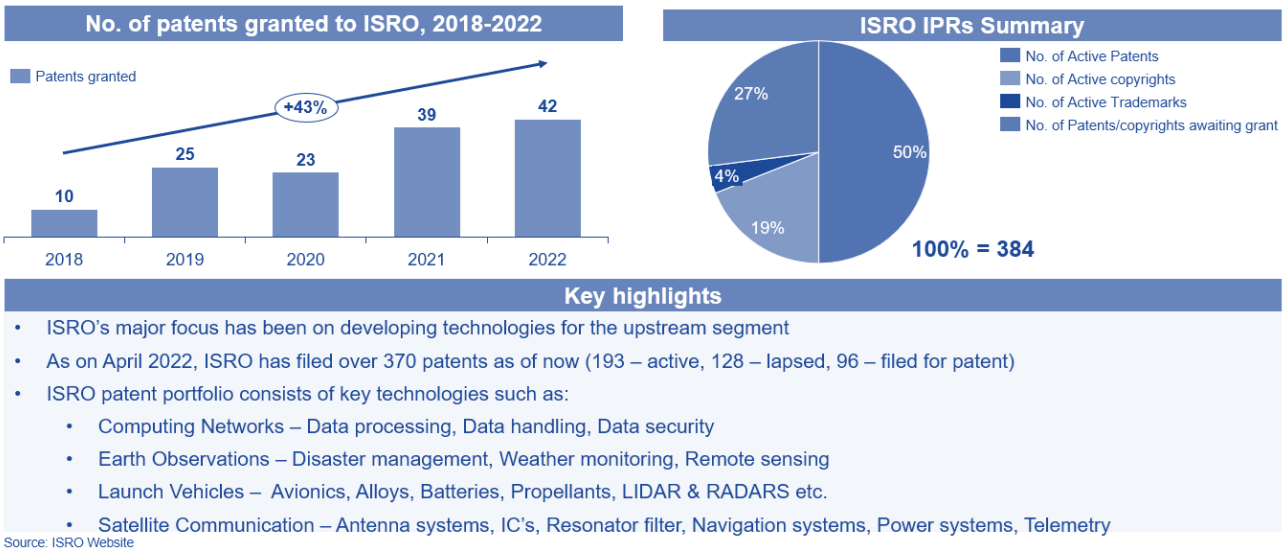


Figure 9. IPRs by ISRO

3.1.4. International collaboration and synergy

ISRO has made significant efforts to enhance synergy and collaboration with international space agencies and other space faring nations by way of signing MoUs and framework agreements to participate on both the mission side and capacity building side. ISRO is also undertaking multiple programs in collaboration with leading space agencies in the world including NASA, CNES, JAXA and ROSCOSMOS. There is also a large list of MoUs signed with more than 50 countries.

Countries with MoUs & framework agreements, region-wise

America	Europe	Middle East	Asia	Russia
United States of America	Bulgaria	Bahrain	Afghanistan	
Canada	Finland	Israel	Armenia	Australia
Mexico	France	Kuwait	Bangladesh	
Argentina	Germany	Saudi Arabia	Bhutan	
Bolivia	Hungary	Oman	Darussalam	
Brazil	Italy	Syria	China	
Chile	Norway	United Arab Emirates	Indonesia	
Peru	Portugal		Japan	
Venezuela	Spain		Kazakhstan	
	Sweden		Maldives	
	Netherlands		Mongolia	
	Ukraine		Myanmar	
	United Kingdom		Nepal	
			South Korea	
			Singapore	
			Sri Lanka	
			Tajikistan	
			Thailand	
			Vietnam, Uzbekistan	

Africa
Algeria
Egypt
Mauritius
Morocco
Nigeria
Sao-Tome & Principe
South Africa
Tunisia

Key Completed Projects

Partner	Mission
USA : NASA	Chandrayaan-1
France: CNES	MEGHA-TROPIQUES
France: CNES	SARAL

Key Ongoing Projects

Partner	Mission
USA : NASA	NISAR
France: CNES	TRISHNA
Japan : JAXA	LUPEX
Russia: ROSCOSMOS	Gaganyaan

Figure 10. List of countries with MoUs and key projects with international space agencies

In addition to signing MoUs for collaboration on space programs, ISRO has also undertaken agreements for knowledge sharing and capacity building across upstream, midstream, and downstream technologies while also for certain student exchange programs, professional exchange

programs, especially in the areas of quantum science and technology, data sharing, joint satellite realization, joint experiments, human space flight, electric propulsion, etc.

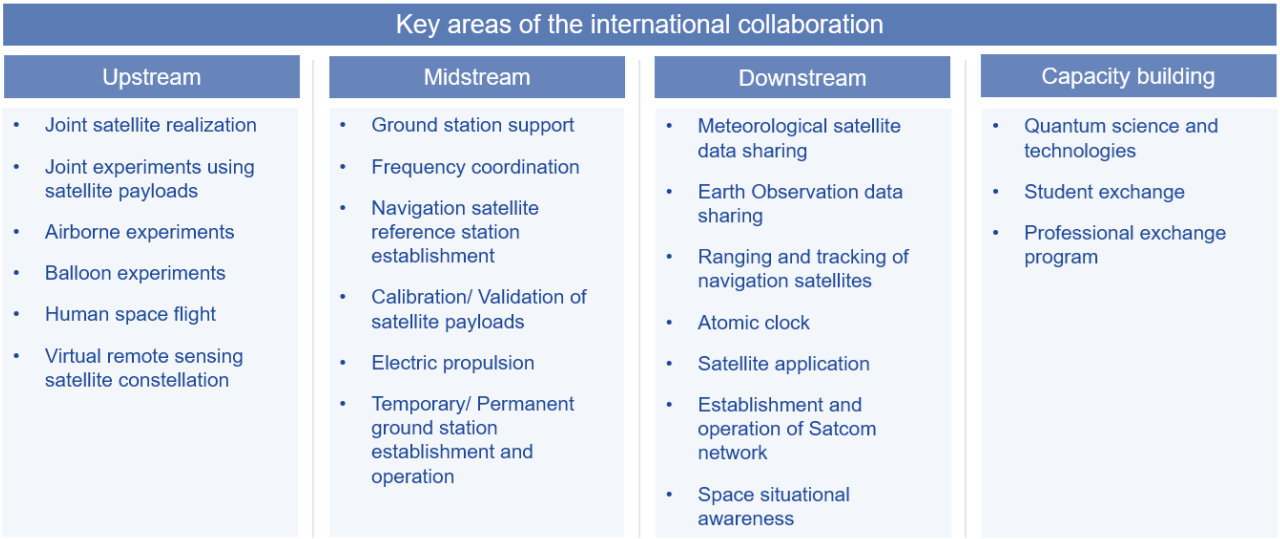


Figure 11. Key areas for international collaboration

3.1.5. Other capacity building initiatives by ISRO

Multiple initiatives have been undertaken by ISRO to enhance the interest in space sector right from the school level, and further through multiple courses, grants, promoting space education through fellowships, and focused programs like YUVIKA and UNNATI.

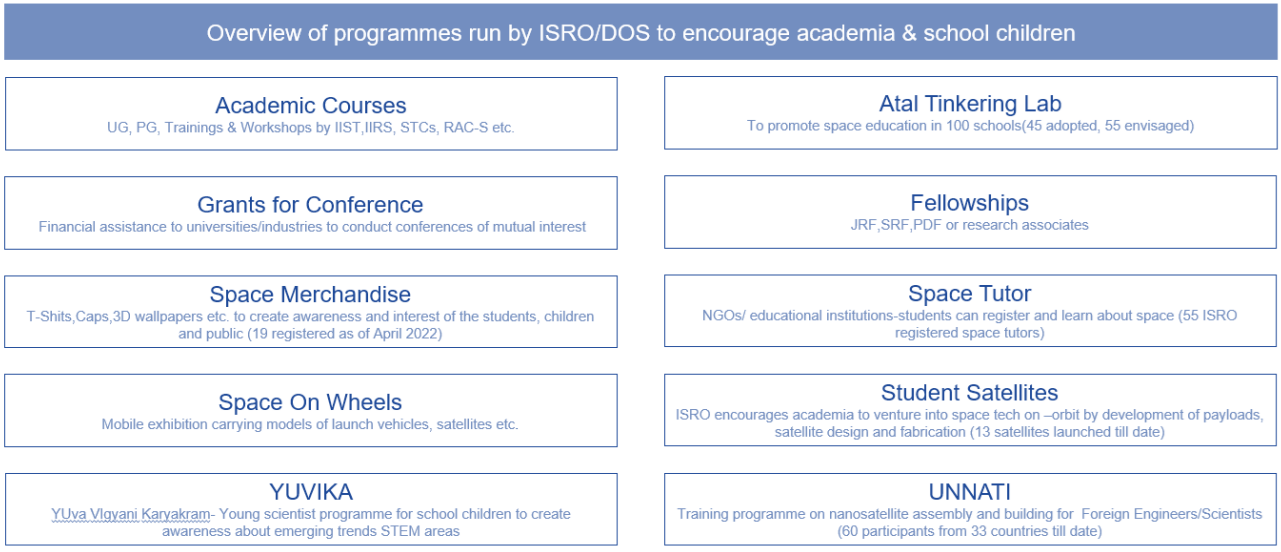


Figure 12. Programs to encourage academia and school children

Space R&D focus at the academic institutes in India has been majorly in the areas of human space flight, launch vehicles, satcomm, EO and meteorology. ISRO has undertaken collaborations with multiple countries. For example, IIRS conducts a joint education program on geoinformatics and natural hazards & disaster risk management with University of Twente, Netherlands. And other 9-month PG diploma course through the Centre for Space and Technology Education for the Asia Pacific (CSSTE-AP). Other institutes like the Aryabhata, Raman Institute of Astrophysics have also engaged in international collaboration and are providing courses in Astrophysics, Astronomy, Remote Sensing, geoinformatics, etc.

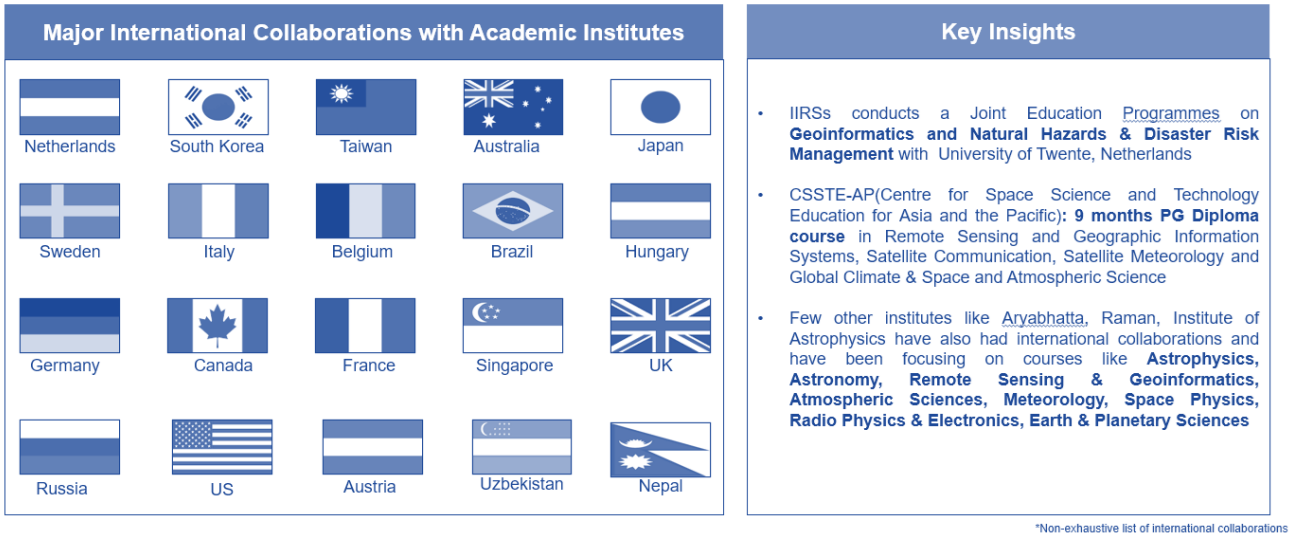


Figure 13. Major international collaborations with academic institutes

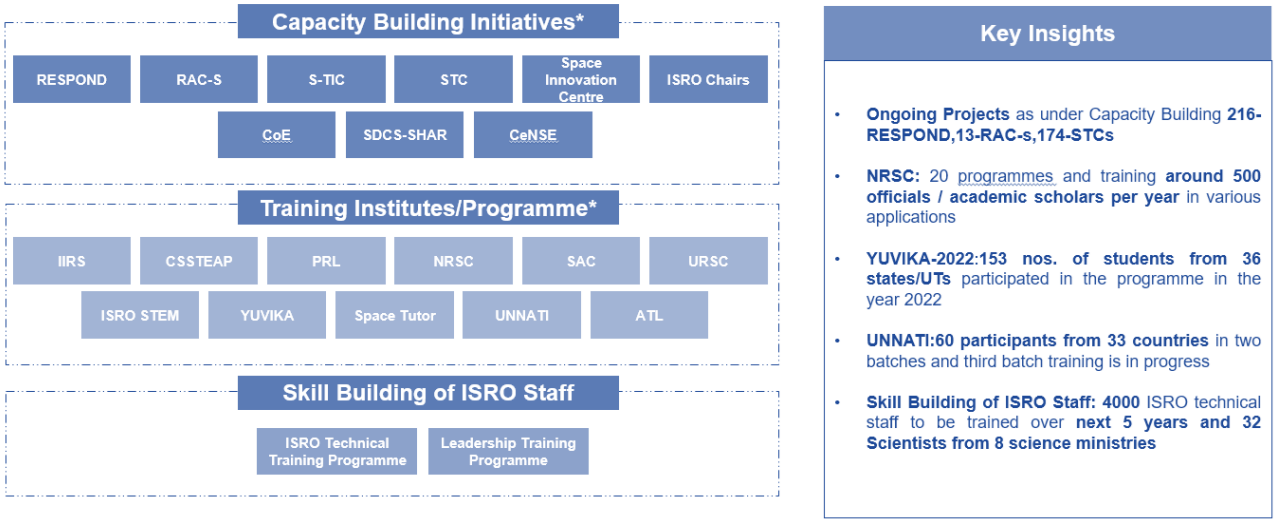


Figure 14. Other capacity building initiatives

3.2. Benchmarking with other space-faring nations

This section aims at giving a brief overview/ summary of how other space faring nations are approaching the Space ecosystem including the capacity building, talent management and upskilling.

3.2.1. United States of America

Because of its active interaction with the commercial sector, NASA is a thriving behemoth. In 2021 NASA allowed commercial users, including private astronauts, to access its portion of the International Space Station.

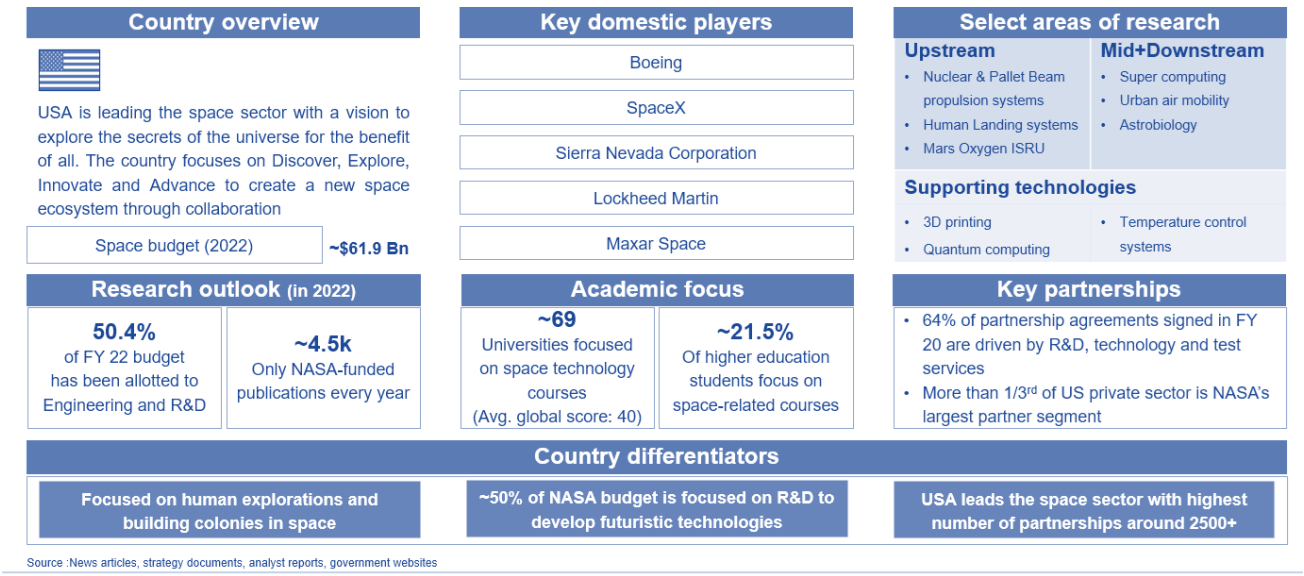


Figure 15. Summary of USA's Space sector initiatives

There has also been focus on higher education in the space sector technologies which has led to increase in the total number of students pursuing higher education in related technologies. There has also been a surge in the number of jobs that are now available for students with skills in the space sector. The CubeSat launch initiative has enabled hands on experience for students and faculty in American universities by providing them a low-cost option to develop skills in flight hardware design. Similarly, the American Rocketry Challenge provides a platform to nearly 5000 students to showcase their skills in design, building and launching model rockets while also giving them hands on experience in solving engineering problems.

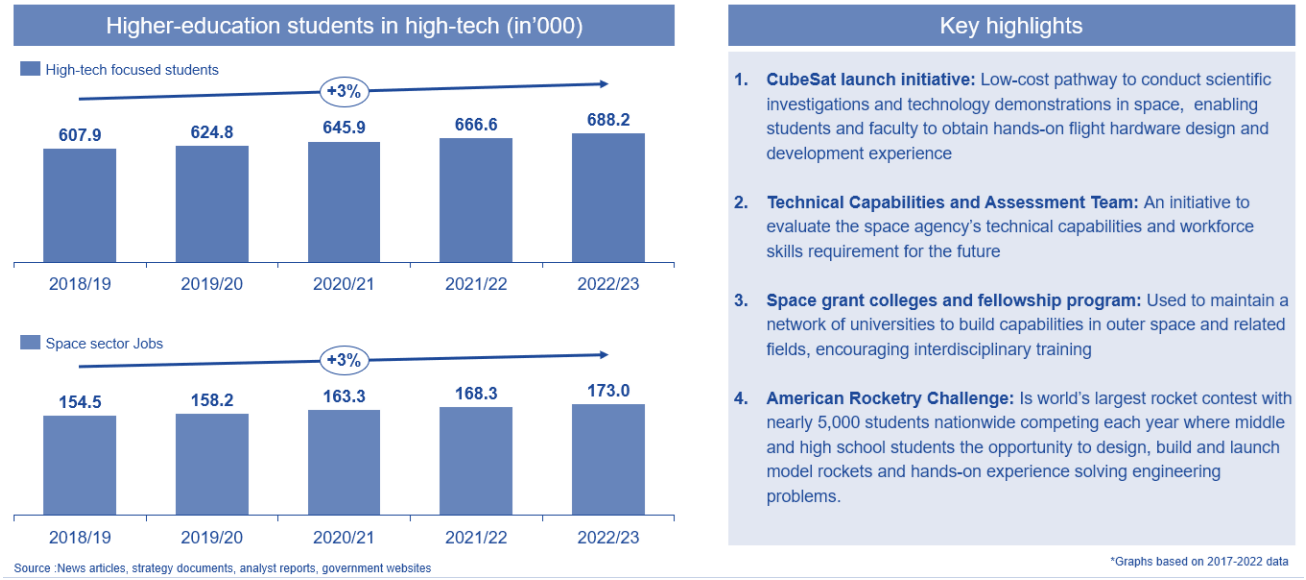


Figure 16. Initiatives by USA to increase skill adoption and development in Space sector technologies

3.2.2. France

France is a key contributor to the European Space program and is in itself an advanced space faring nation. There have been multiple programs run by the French space agency under the larger umbrella of the ESA. France has the fourth largest Space budget in 2022 focused on emerging technologies especially in the microsatellites and mini-launchers segment. There is sufficient focus on capacity building, academia and partnerships and takes lead in the EO segment worldwide.

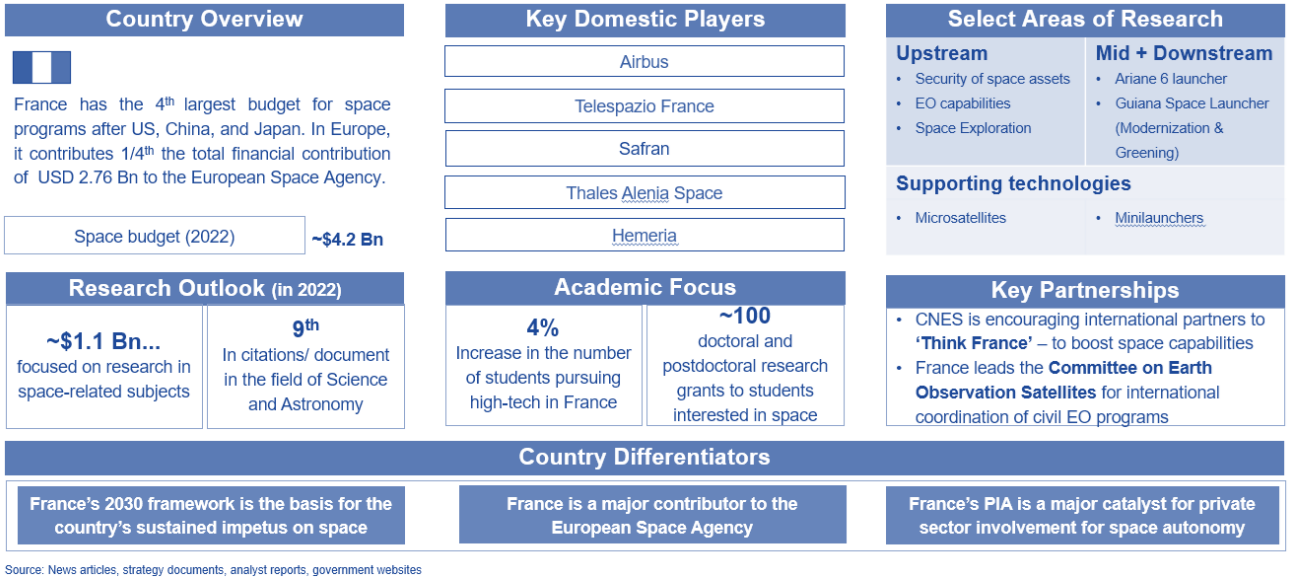


Figure 17. Summary of France's Space sector initiatives

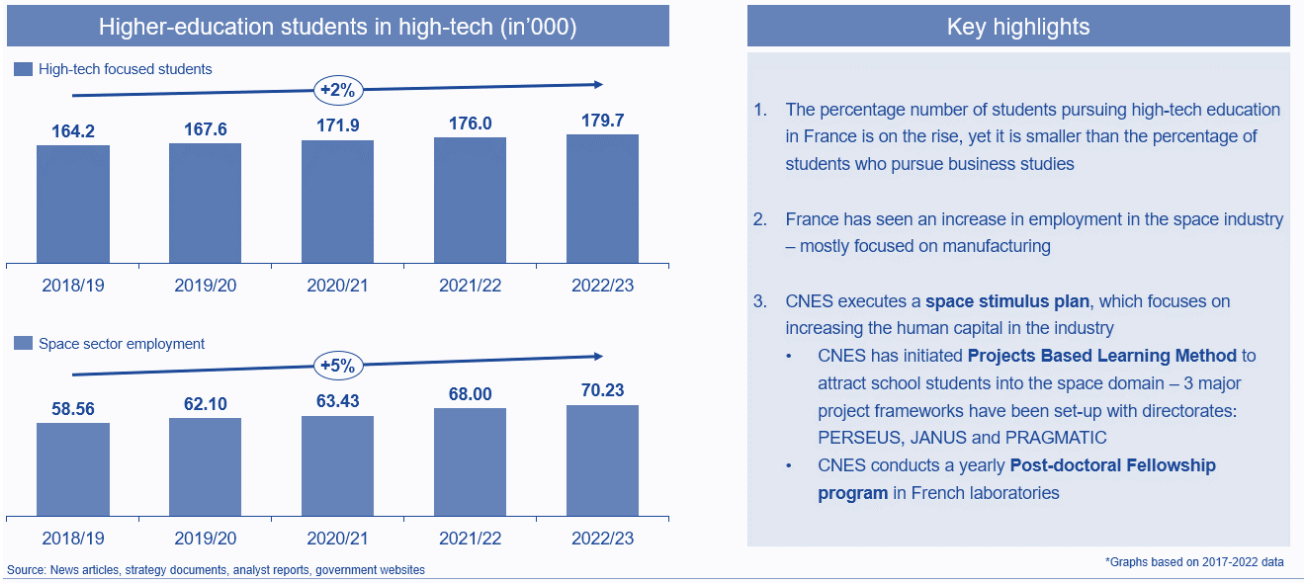


Figure 18. Initiatives by France to increase skill adoption and development in Space sector technologies

While France has increased its focus on higher education in the Space sector, there still is less adoption by its students as a larger number of them pursue business studies. There have been multiple programs like the space stimulus plan, project-based learning methods, e.g., PERSEUS, JANUS, and PRAGMATIC. The Centre National D'Etudes Spatiales (CNES) is the major center focusing on capacity building and capability development in the Space sector and runs a post-doctoral fellowship program in French laboratories in addition to the above initiatives.

3.2.3. Japan

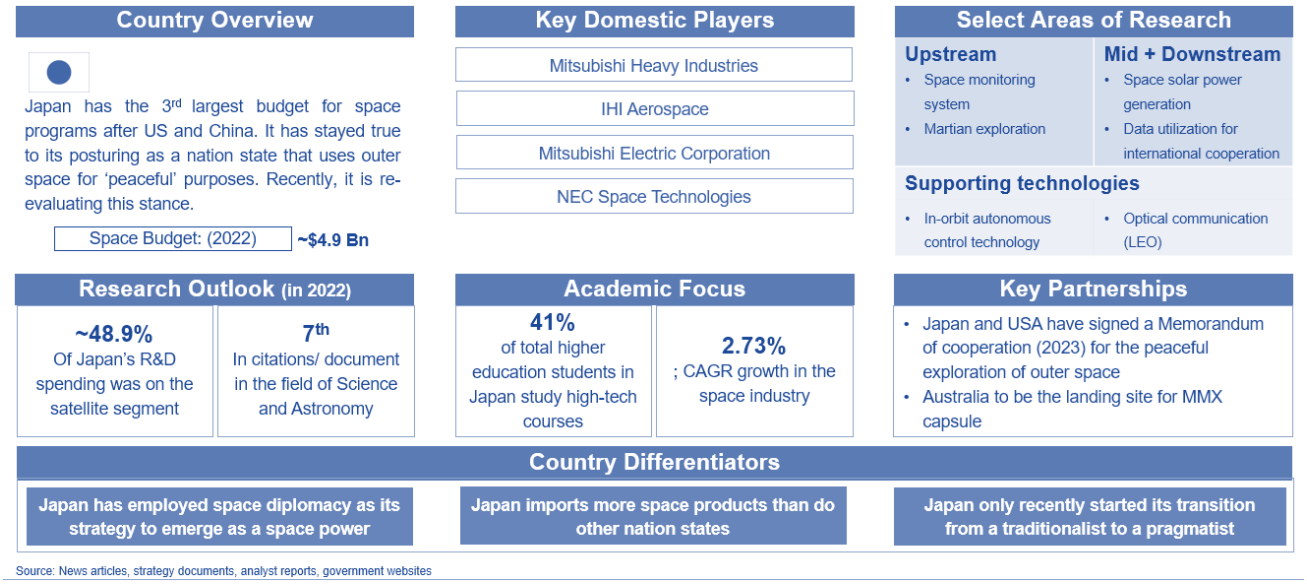


Figure 19. Summary of Japan's Space sector initiatives

3.2.4. Australia

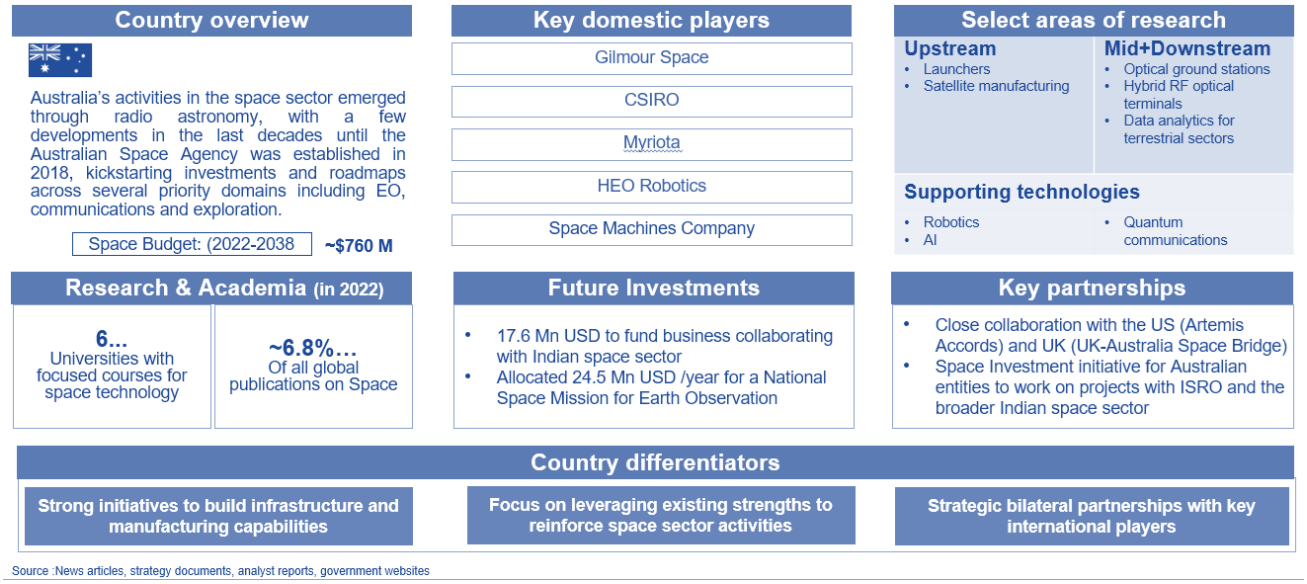


Figure 20. Summary of Australian initiatives in the Space sector

3.2.5. United Arab Emirates

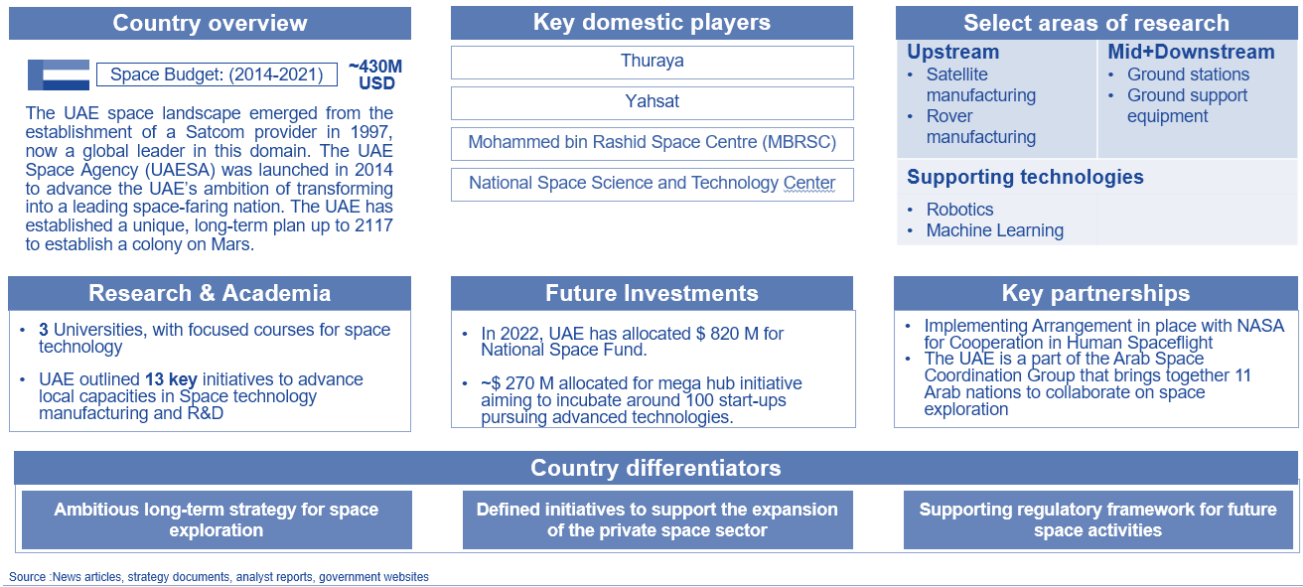


Figure 21. Summary of UAE's initiatives in the Space sector

3.2.6. Luxembourg

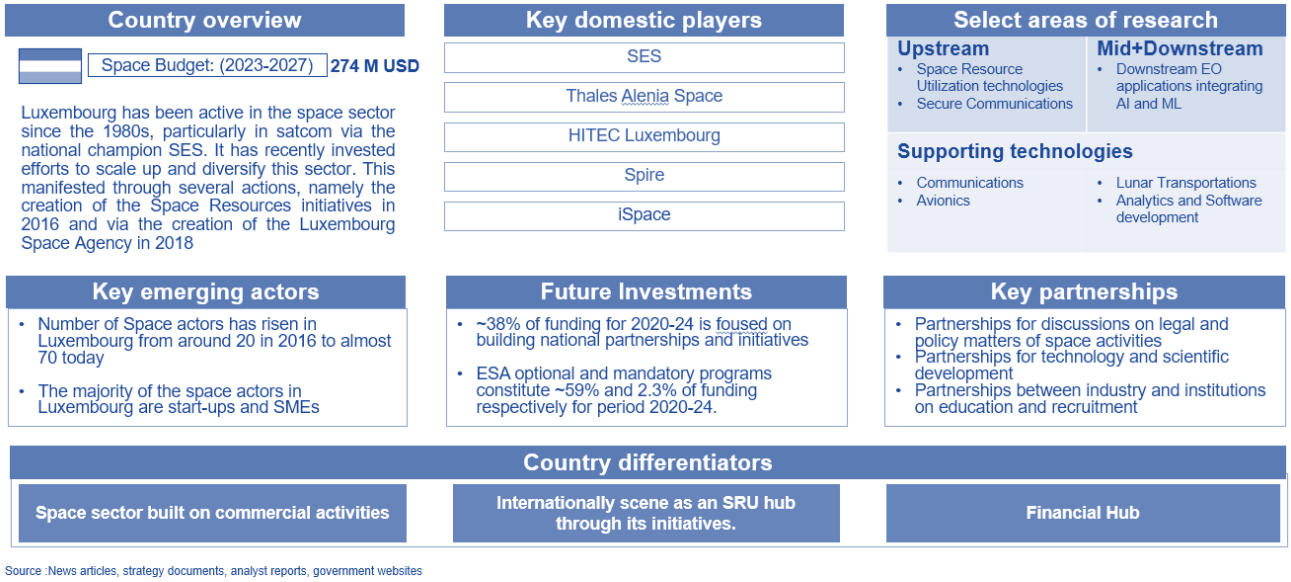


Figure 22. Summary of Luxembourg's Space sector initiatives

3.2.7. Israel

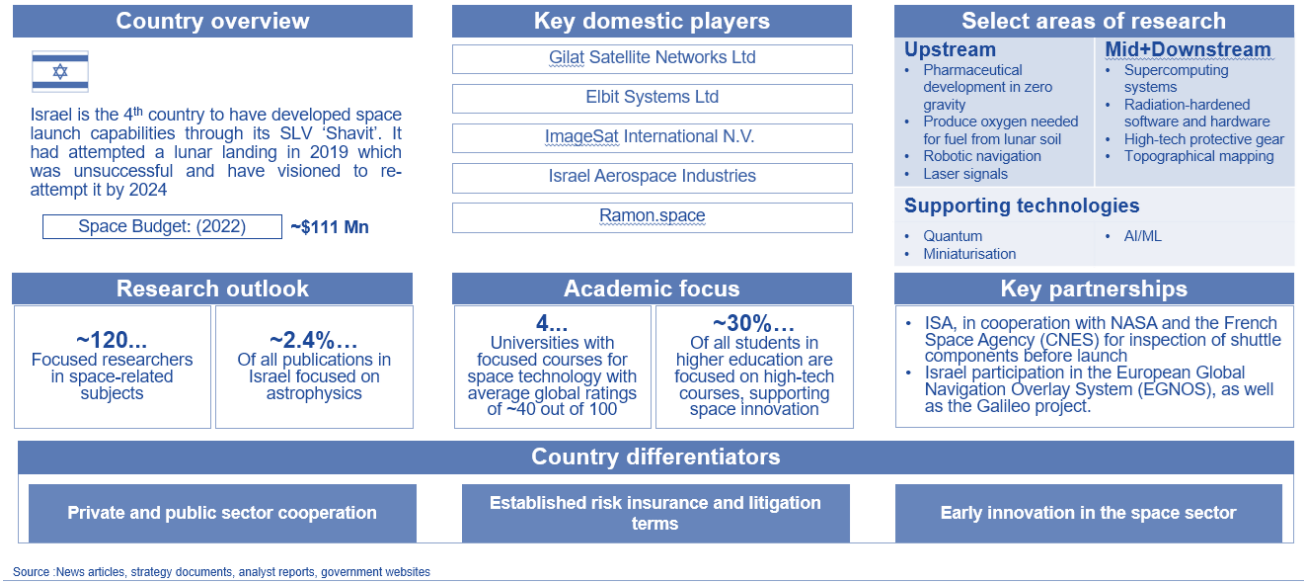


Figure 23. Summary of Israel's Space sector initiatives

3.2.8. South Africa

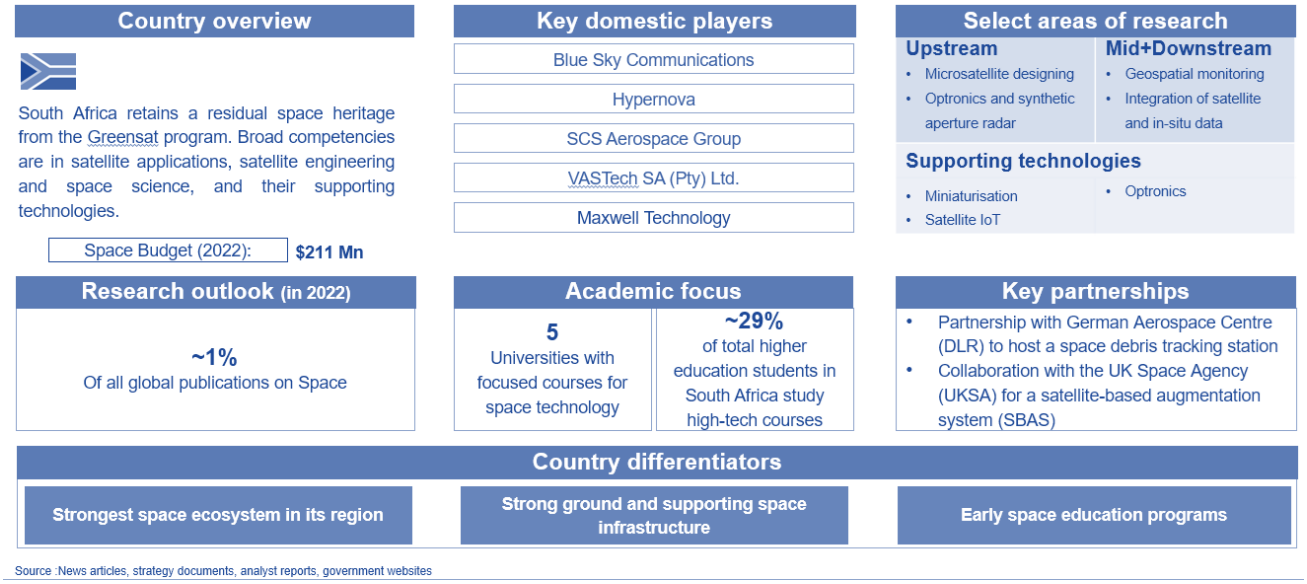


Figure 24. Summary of South Africa's Space sector initiatives

In addition to the country specific initiatives above, the succeeding sections cover certain other salient aspects of various space agencies/ space faring nations.

3.3. Benchmarking with Space Agencies (non-exhaustive)

3.3.1. European Space Agency

ESA is an intergovernmental agency that was established in 1975 with the goal of directing the advancement of Europe's space capacity and making sure that investments in space benefit both European and global populations. ESA is able to carry out projects and operations that are well beyond the capabilities of any one European nation by coordinating the financial and intellectual resources of its members[12].

They key features of ESA Procurement system are-

a. **Long term Collaborations** – Several long-term partnerships have been forged by ESA including with Airbus defense which has been a strategic partner of ESA since past 30 years. Such partnerships lead to greater synergies between private and public sectors

b. **Centralized Procurement System:** ESA is responsible for the procurement of goods and services of all the 22 member states and thus has a more centralized system

[12] Available at https://www.esa.int/About_Us/Corporate_news/About_the_European_Space_Agency

c. **ISRO has a decentralized system**[13] with individual ISRO Centers and departments responsible for managing their own procurement. Though even ISRO has a centralized Vendor registration system and procurement policy that needs to be followed by all centers and units

d. **Business Incubation Centers:** The largest network of incubators helping start-ups in the space industry in Europe is comprised of ESA Business Incubation Centers (ESA BICs). The goal is to assist entrepreneurs with space-related business ideas in developing their products and starting their businesses. They develop and expand clusters of space-related start-ups throughout Europe as a result. There are more than 54[14] incubation centers all across Europe which provides the following support[15]-
    a. Up to two years of business incubation at an ESA BIC
    b. Technical support from leading experts in the region and from ESA
    c. Business coaching
    d. Legal and IPR advice
    e. Access to business partners and networks
    f. Workshops and trainings
    g. Fundraising guidance and opportunities
    h. €50k funding for product and IP development

e. ISRO has established a **Space Technology Incubation Center** in each of the six geographic regions of our nation: Central, East, North, North-East, South, and West. The goal of these centers is to draw and support young academics with creative ideas and research aptitude for conducting research and developing the ecosystem of academia and industry for space technology. The young academics will be able to realize their creative concepts and research abilities into space-grade components and materials that may be used for space applications, and this will help them set up the future start-ups.

3.3.2. NASA

Because of its active interaction with the commercial sector, NASA is a thriving behemoth. In 2021 NASA allowed commercial users, including private astronauts, to access its portion of the International Space Station.

With the establishment of IN-SPACe (Indian National Space Promotion and Authorization Center) and New Space India Limited (NSIL), India may have made its first significant move in that direction. NSIL was established as a supporting organisation for the ISRO to enable private participation in its projects. The system for ISRO's involvement with industry and to satisfy the needs of the private sector in space missions will be developed by IN-SPACe. India though has a long way to go in the collaboration with the private sector.

[13] Available at https://www.isro.gov.in/Procedure_followed.html, https://www.isro.gov.in/Tenders.html
[14] Available at https://www.esabic.ch/about/
[15] Available at https://commercialisation.esa.int/esa-business-incubation-centres/

The major examples of NASA's PPP are its Commercial Crew Program. In order to achieve safe, dependable, and affordable access to and from the space station and other locations in low-Earth orbit, NASA's Commercial Crew Program is collaborating with partners SpaceX and Boeing to build a U.S. commercial crew space transportation capability. Commercial transportation to and from the station will increase the usability of the orbiting laboratory, provide researchers more time to do study there, and open up more prospects for discovery.

- Presently, ISRO has partnerships with 150 or more private businesses already. NASA collaborates with more than 375 space companies

- ISRO needs to expand its partnerships further. This may be done through streamlining the process if registration at the incubation centers and the PPP policies

For knowledge sharing between NASA and external partners there are agreements called Cooperative Research and Development Agreement (CRADA)[16]

3.3.3. Canadian Space Agency

Canadian Space agency's mandate includes increasing understanding of space via science and work to ensure that Canadians benefit from space science and technology in terms of their social and economic well-being.

As the Canadian Space agency has a limited budget it has to carefully allocate its resources. Just like India, it has a strong focus on low-cost innovation and has developed several innovative solutions to space technology challenges. Due to this reason, it is focusing of developing niche capabilities which will be world renowned along with creating well-paying jobs for the middle classes

One of Canada's specialties is space medicine, which is essential for safe and effective crewed space missions as well as for the advancement of medical knowledge and skills that can open doors (and improve health) for Canadians on Earth. As part of its commitment to Artemis, Canada will build the Canadarm3, which similarly requires expertise in both robots and artificial intelligence—two technical fields that may spur innovation, generate jobs, and help Canadians compete in a market disrupted by new technology.

3.3.4. Chinese National Space Administration

The China National Space Administration (CNSA) looks after the space program of the People's Republic of China. It is highly funded by the government and thus has a huge budget compared to India.

[16] Available at https://invention.nasa.gov/technology-transfer.php

Space Station Development: The CNSA has developed a modular space station and plans to launch several modules to assemble it in space. ISRO could potentially learn from the CNSA's experience of developing a space station and use this to develop its own.

3.3.5. Israeli Space Agency

The Israel Space Agency, established in 1983 as a result of a government decision, is a national organisation operating under the Ministry of Science and Technology. The Agency is in charge of initiating, overseeing, and coordinating all aspects of the civilian space program, and it particularly supports scientific research and development that has the potential to have a positive impact on the economy, such as the creation of novel and innovative technologies.

- ISA has been able to make great progress in the field of space in a very short period of time. It has leveraged the private sector extensively for the purpose. The SpaceIL lunar lander was the first privately funded mission to land on the moon. Israeli company SpaceIL was founded in 2011 and participated in the Google Lunar X Prize (GLXP) competition to land a spacecraft on the Moon.

- The Space IL team was established as a nonprofit with the goal of advancing science and technology education in Israel. The Israel Space Agency (ISA) and other charities, as well as Israeli billionaire Morris Kahn, are contributing to the mission's anticipated US$95 million overall budget

- Similar private collaborations should be enabled in India as well. India is already working on building a national policy for space which would further enhance such collaborations. The Indian Space Policy 2023 has been approved by the Cabinet Committee on Security. The policy seeks to institutionalize private sector participation in the space sector, with ISRO focusing on research and development of advanced space technologies.

3.4. Knowledge Management Systems

3.4.1. Mandating KM Plans

NASA Procedural Requirements and NASA Policy Directives (NPR 7120.5E and NPD 7120.6, respectively) require that project and program plans include a Knowledge Management Plan[17].The project manager is ultimately responsible for implementation of the Knowledge Management Plan and should delegate responsibilities for specific activities within the Knowledge Management Plan, such as:

- Who will be responsible for scheduling and organizing Pause and Learn sessions, gathering lessons learned, documenting case studies, and communicating with leadership?

[17] Available at https://appel.nasa.gov/wp-content/uploads/2018/04/Developing-a-KM-Plan_V3.pdf

- Who will be responsible for learning from other projects?
- If the responsibility is shared across the project, make it as specific as possible

3.4.2. Chief Knowledge officer

Every NASA center and mission directorate has an appointed Chief Knowledge Officer (CKO), In compliance with NASA Policy Directive 7120.6. The Office of the Chief Knowledge Officer (OCKO) is responsible for assuring that the Center operates as a learning organization. It is responsible for policy and guidance on Lessons Learned, Knowledge Management and Learning Practices.

3.4.3. ML Based KM System

The Artificial Intelligence & Operations Innovation Team of ESA is developing an ML based knowledge management system called KITE. KITE is a knowledge management tool powered by state-of-the-art text mining and machine learning. KITE can discover network of expertise across ESA colleagues based on available textual documents (e.g., technical notes, reports, papers, etc.). KITE can also support the identification of which ESA colleagues has competence on specific domain of expertise[18]

3.4.4. Ombudsman Program

The NASA Ombuds Program[19] was laid out in 2005 as a casual, free, private, and unbiased method for imparting and working with the goal of wellbeing, authoritative execution, and mission related issues unafraid of reprisal. The Jet Propulsion Laboratory and all NASA Centers have Ombudsmen who will listen to an employee's concerns, investigate options, and weigh the advantages and disadvantages of various options for resolution. At each location, the Ombudsman writes to the Center Heads.

Students, on-site contractors, and civil servants all benefit from the Ombuds Program. An individual may decide to utilize the Ombuds Office if;

- They have already been to formal resources and do not believe the process was fair.
- They believe the formal resource is too close to the situation to be impartial.
- They want to raise an issue and not be identified as the source of the information.
- They do not know what formal resources are available to them.

A similar program may be started at all centers and units of ISRO as well

[18] Available at https://esoc.esa.int/innovation-artificial-intelligence-projects
[19] Available at https://www.nasa.gov/offices/ombuds

3.4.5. Knowledge Capture and Transfer Tools

Nasa has developed several tools for the benefit of their teams and missions, individuals who retire or switch from one project or program to another for career development and growth possibilities leave behind significant knowledge gaps. These include

a. **Panel discussions and focus groups** give experts the opportunity to have a dialogue with colleagues and contribute their knowledge through stories and interactions. When there is sufficient time to set up a panel discussion or group conversation, teams can benefit from having a shared experience and some members of the team will pick up insights that others might miss.

b. **Video capture** can help illuminate the personality and experience of an expert. Video capture practices can range from one or a few long-form interviews to short snapshots of a specific practice or specific leadership advice. Using video capture reduces the amount of editing and review necessary for the interviewee, and it helps to ensure that the information collected is exactly what was said.

c. **Set up meetings and pre-exit interviews** to help ensure that unique information, procedures, and documents are all identified. In these conversations, be sure to discuss lessons learned, points of contact, and any additional tips and resources that might not otherwise be documented.

d. **Tools for Documenting Tasks and Roles:** Completing a template that outlines the purpose, key tasks, work products and their locations, important milestones and contacts is a useful resource for anyone taking over a job because of a long-term changeover (a family obligation, work detail, or another extended commitment) or employee's permanent departure. The template can be used for the entire job function or for individual tasks[20].

[20] https://appel.nasa.gov/wp-content/uploads/2022/03/kct-task-documentation-example.pdf

4. Emerging Technologies

The Indian Space Research Organisation (ISRO) is working to create a number of cutting-edge technologies as the race for space accelerates. This covers technological innovations including quantum communications, self-destructing satellites, and humanoid robots etc. Some of these technologies have been explained below. Further, a few more technologies which are comparatively new may also be looked at by the Department of space have also been listed.

4.1. Quantum Technologies

Quantum technologies have the ability to solve very advanced computational challenges and may theoretically be able to solve certain problems in a few days that would take millions of years on a classical computer. The usage of these would dramatically improve the DoS ability to address difficult optimization and machine learning problems arising in ISRO's aeronautics, Earth and space sciences, and space exploration missions21. It would also provide unconditional data security against eavesdroppers. Some of the use cases include-

- Satellite Based Quantum Communication
- Quantum Radars

It is envisioned that global quantum communications networks will involve a combination of quantum-satellite constellations—providing intercontinental connectivity—and fiber quantum networks—connecting metropolitan networks on the ground. But besides technological applications, satellites could also enable intriguing fundamental tests at the intersection of quantum physics and relativity. The speeds, distances, and variations in gravity accessible with space-based experiments will allow researchers to probe how gravity affects quantum phenomena, which could pave the way toward the development of a quantum gravity theory

In January 2022, Space Applications Centre (SAC) and Physical Research Laboratory (PRL) successfully demonstrated quantum entanglement based real time Quantum Key Distribution (QKD) over 300m atmospheric channel along with quantum-secure text, image transmission and quantum-assisted two-way video calling22. In March 2023, Telecom minister Ashwini Vaishnaw informed that the country's first quantum computing-based telecom network link is now operational in the national capital23 developed by C-Dot.

ISRO needs to further accelerate its efforts for building a quantum communication-based satellite. It may study the experience of the Chinese Academy of Science which launched Micius -quantum communications satellite in 2016, produced a string of exciting first demonstrations in quantum space communications.

[21] Available at https://www.nasa.gov/content/nasa-quantum-artificial-intelligence-laboratory-quail
[22] Available at isro.gov.in/DeptofSpace.html
[23] Available at https://indianexpress.com/article/business/india-first-quantum-computing-based-telecom-network-link-now-operational-ashwini-vaishnaw-8521123/

4.2. Sustainable Space

To ensure a more holistic and sustainable approach to space missions it is necessary to minimize addition and clearing of debris and protecting the space assets. The following emerging technologies need to be further developed and incorporated into India's space missions-

- Self-Eating Rocket: ISRO is working on technology through which rockets will be able to eat themselves, eliminating waste dropped into seas and space debris. This would include special materials for casing which can burn up along with motors24
- Self-Destructing Materials: ISRO is working on this technology which would include self-vanishing satellite technology enabling spacecrafts to self-destruct once its lifetime is over, with the help of a 'kill button'24
- Self-Healing Materials: The world's toughest self-healing material has been discovered by scientists from the Indian Institute of Science, Education and Research in Kolkata and the Indian Institute of Technology in Kharagpur25. Due to its special features, this material can be used in space probes, drones, and precision engineering.
    - Such tough self-healing materials can rapidly fix themselves in case a portion of a space mission sustains damage after touching down on the surface of the Moon or Mars etc.
- Space Robotic Arm: A state-of-the-art robotics lab for the design and development of robotic arm and docking mechanisms was established in 2022, at ISRO26

Further, to institutionalize its efforts, Safe & Sustainable Operations Management has been setup which is responsible for safeguarding ISRO's operational space assets against space environmental threats and for ensuring that ISRO's outer space activities are conducted in a safe and sustainable manner.

DoS may further look at collaborating with national institutes like IIT's, IISER etc. along with global institutes for sharing of knowledge that already exist with them and to ensure cross sectoral transfer of technologies. Public private partnerships with companies like Pixxel27 which is working on self-eating rockets, may also be encouraged.

In addition to these the following technologies will be important for a sustainable space mission as well in the future. These have been explained in detail in the following sub sections-

- Orbit Servicing, Assembly and Manufacturing (OSAM)
- Reusable Rockets: ISRO has a Reusable Launch Vehicle (RLV) program to develop a wing body reentry vehicle similar to that of an aircraft

4.2.1. Orbit Servicing, Assembly and Manufacturing (OSAM)

In addition to above Orbit Servicing, Assembly and Manufacturing (OSAM) activities may be looked at as well. United States has the widest range of Orbit Servicing, Assembly and Manufacturing

[24] Available at https://www.deccanherald.com/national/self-eating-rocket-to-self-healing-material-isro-to-develop-futuristic-technology-as-space-race-intensifies-1053981.html
[25] Available at https://www.deccanherald.com/science-and-environment/indian-scientists-breakthrough-on-self-healing-material-may-lead-to-exciting-future-1010431.html
[26] Available at https://www.isro.gov.in/media_isro/pdf/AnnualReport/Annual_Report_2022_23_Eng.pdf
[27] Available at https://www.theweek.in/news/sci-tech/2021/11/25/why-self-eating-rockets-vanishing-satellites-are-here-to-stay.html

(OSAM) activities, closely followed by Russia and China. India currently does not have an OSAM ecosystem.

These capabilities are key to develop as they would extend the lifespan of satellites and reduce space debris. In dollar terms, the satellite services and applications segment would be the largest with a turnover of USD 4.6 billion by 2025, followed by ground segment at USD 4 billion, satellite manufacturing at USD 3.2 billion and launch services at USD 1 billion28.

To begin with, ISRO may look at pursuing supporting business conditions where the private area can develop and advance the movement of OSAM through cooperation with the government (e.g., Luxembourg, the Assembled Realm, and the US). The government is mostly or completely in charge of OSAM-related activities in other nations (China and Russia, for example).

4.2.2. Reusable Rockets

ISRO has been making progress in the area of developing its own reusable rockets. In 2021, ISRO Chairman has announced that the agency was working on a two-stage-to-orbit reusable launch vehicle, which would be capable of launching and landing like an airplane. The project is in the development stage.

ISRO may use private participation to quicken this process as done by NASA through private space companies such as SpaceX and Blue origin, who have successfully demonstrated the ability to land and reuse rocket booster, which can significantly reduce launch costs

4.3. AI and Robotics

Artificial Intelligence, Machine Learning (ML) and Robotics are currently being used in the space industry to help scientists analyze data more quickly and accurately and automate operations on spacecraft. Using AI rovers can navigate around obstacles by autonomously finding their way across 'unknown' fields. Artificial intelligence is also aiding astronauts on board the International Space Station. Some of the specific use cases for these technologies in India, on which ISRO is working include-

- In-Orbit Integrated Spacecraft Health Management
- Humanoid Robots
- Ground Water Level Prediction with Remote Sensing
- AI-based Weather Prediction

Chandrayaan 2, Multi Object Tracking Radar, Image Processing and Pattern Recognition, Monitoring System for Forest Conservation, and Autonomously Navigating Robot are examples of how ISRO has advanced thanks to the use of AI. ISRO has also created an artificial intelligence-enabled monitoring system for forest protection for the National Remote Sensing Centre (NRSC)29. In Chandrayaan 2, the Pragyan rover was AI-powered which can communicate only with the Lander30. It has also developed the Autonomously Navigating Robot for Space Mission (IISU) which uses Artificial

[28]Available at https://theprint.in/india/isro-eyes-next-generation-launch-vehicle-for-heavier-payloads/1187931/
[29] Available at https://indiaai.gov.in/article/how-ai-helped-isro-to-reach-its-pinnacle
[30] Available at https://developer-shubham-rasal.medium.com/how-isro-uses-machine-learning-25be23430713

Intelligence / Machine Learning enabled real time decision making with vision optimization and path planning algorithms.

Other space organizations have also been extensively using AI & Robotics. NASA created the technology for autonomous driving for Mars Rovers a decade ago. An ML based navigation and driving system for self-driving Mars rovers known as AutoNav was used in the Spirit and Opportunity rovers which landed on Mars in 200431. NASA is also working on Exploration Medical Capability that will use Machine Learning to develop healthcare options based on the anticipated future medical needs of the astronauts. They have also built and designed a robotic astronaut called Robonaut. A Robonaut is a dexterous humanoid robot at NASA Johnson Space Center in Houston, Texas which uses set of machine learning and artificial intelligence techniques that are roughly modeled after human cognition, to think for itself32.

4.4. Solar System Exploration

Solay system exploration would enable planetary and interplanetary missions, extending human reach to Moon, Mars and beyond. ISRO is presently working on developing the following technologies-

- In-Situ Propellant Production at Moon and Mars
- Reconfigurable Rover
- Lunar Environmental Simulation Test Facility

These three technologies are in their novel stages of development throughout the world. ISRO may focus on increasing international and national collaboration along with Human resource development in these fields to become a leading organisation for solar system exploration.

NASA and ESA created a 16-member Mars Sample Return Campaign Science group in 2022. The group will create the roadmap to bring back and analyze samples from Mars. It will involve the first mission to return samples from another planet and the first to launch from the surface of another planet33. Such collaborations and knowledge transfers with leading institutes may be encouraged at DoS as well.

4.5. Energy Management

India has become the most populous country in the world with its energy demand projected to increase at a very fast pace in the future. Technologies such as Space Based Solar Power, Low Temp. Lithium-ion cells and Roll-Out Solar Array would become key to ensure energy security in the country. Thus there is a need to focus on the development of –

1. Solar power
2. Green propellants
3. Li-Ion Batteries
4. Hydrogen Cell

[31] Available at https://mars.nasa.gov/mars2020/mission/status/342/driving-farther-and-faster-with-autonomous-navigation-and-helicopter-scouting/
[32] Available at https://ntrs.nasa.gov/api/citations/20180001747/downloads/20180001747.pdf
[33] Available at https://indianexpress.com/article/technology/science/nasa-esa-mars-sample-returns-campaign-science-group-7971136/

For Space based solar power several countries are making their concept studies. ESA has signed contracts for two parallel concept studies[34] for commercial-scale Space-Based Solar Power plants, representing a crucial step in the Agency's new SOLARIS initiative – maturing the feasibility of gathering solar energy from space for terrestrial clean energy needs

A lot of research and development would be required over the next two decades to make these emerging energy systems a reality. These will also lead to many technological spin-offs. ISRO may focus on private sector/ academia collaborations and further developing its innovation management to tap into the full potential of this growing space energy sector

4.6. In-Space Manufacturing

In-space manufacturing would include development of the following-

- Inflatable structures
- Space materials
- Space Robotics
- Space Mining

Space mining has been further detailed below

4.6.1. Space Resource Utilization/Space Mining

Space Resource Utilisation (SRU) will be an important aspect of a sustainable human presence off Earth, initially at the Moon and Mars. The use of local resources is a way to decouple activities away from Earth and from the costs associated with the need to launch supplies from Earth's deep gravity well. Structures, consumables, energy, parts, and equipment may at some point be produced, entirely or in part, from space materials sourced on-site or from a nearby extra-terrestrial body, to reduce cost and allow adaptability and flexibility for exploration architectures and scenarios. It is this change of paradigm, to implement production at the point of need from local materials, that can make space exploration sustainable in the long term.

AS an example, metals present in regoliths can be extracted via mineral reduction processes. Other structural materials such as roads and landing/launch pads may be built from sintered raw material. An important application for in-situ construction materials will be the protection of habitats (perhaps inflatable) from cosmic rays and solar radiation. Although water and polymers offer the most efficient protection, an equivalent level of protection can be achieved. Such protection schemes may be easier to maintain over a long period of time, can be produced from local materials, and offer protection against micro-meteoroid impacts[35].

While SRU has been a domain under consideration for many years, it has been restricted to some developed nations like the US who chose to invest in it. Now the domain us being considered by other space faring nations, including India. In the future, to be able to explore the SRU domain further, Dept of Space will need build capability in the domain.

[34] Available at https://www.esa.int/Enabling_Support/Space_Engineering_Technology/SOLARIS/ESA_developing_Space-Based_Solar_Power_plant_plans
[35] Available at https://www.sciencedirect.com/science/article/abs/pii/S0032063319302077

5. Demand Analysis - Competency Mapping and Capacity Need Analysis for Scientists/ Engineers and Technicians/ Scientific Assistants

5.1. Competency Mapping for Scientists/ Engineers

5.1.1. Competency Mapping Process

ISRO has 20 centers across India with a total capacity of around 16,224 staff at present. Most of the scientific personnel are concentrated in 5 centers namely:

a. Vikram Sarabhai Space Centre Thiruvananthapuram
b. U R Rao Satellite Centre (URSC), Bengaluru
c. Satish Dhawan Space Centre, Sriharikota
d. Space Applications Centre, Ahmedabad
e. Liquid Propulsion Systems Centre, Trivandrum.

The competency mapping for scientists was done by department. The Annual CBP entailed interactions with at least 10 scientists at every level, covering department heads with appropriate tabulation of the role and function wise competency required, gaps thereof and training needs emanating from this exercise. Representatives of CBC held at least 2 interactions per officer over a period of less than three months to complete the tabulation exercise and to arrive at the priority initiatives to be taken in a phased manner, also making it an institutional exercise. The competencies required have been identified into three categories namely:

a. Domain/sectoral knowledge requirements – Specific expertise related to the space sector and the respective focus area. E.g., Space technology, Rocket science, etc.
b. Functional competency requirements – Covering functional aspects or operational requirements of the departments like project management, financial management, Procurement Management and technological know-how and other non-training interventions like intranet needs for vendor management, file management, etc.
c. Behavioural competency requirements – Soft-skills, attitudinal needs like for intra-department coordination needs, negotiation skills, working with a team, etc.

Figure 25: Three Pillars of Capacity Building[36]

5.1.2. Competency Analysis and Key Findings

The objective of Capacity Building Commission includes covering the competencies in Domain, Behavioral and Functional skills. For Science and Technology Departments, given the uniqueness of the field or the sector they operate in, it is to be managed by the Department/ministry themselves. The current exercise shall mostly cater to behavioral and functional competency needs of the scientists and allied staff. Scientists from all levels and centres spread across the country have chosen the below behavioural and functional competency needs with organizational targets, national priorities and individual aspirations in mind.

Various institutes/units of ISRO were covered in the capacity needs assessment as detailed below

S.No.	Organization	Number of staff covered in CNA
1.	Vikram Sarabhai Space Centre and Liquid Propulsion System Centre (LPSC)*	-
2.	Space Applications Centre	32
3.	U.R. Rao Satellite Centre	-
4.	Satish Dhawan Space Centre	287
5.	Human Space Flight Centre	79
6.	ISRO Telemetry, Tracking and Command Network	244
7.	Master Control Facility	164
8.	ISRO Inertial Systems Unit	207
9.	National Remote Sensing Centre	315
10.	ISRO Propulsion Complex	165
	TOTAL	~1500

Table 6: Coverage of Capacity Needs of Scientist/Engineer staff

[36] Source: CBPO, ISRO

5.1.2.1. Behavioural Competency Analysis

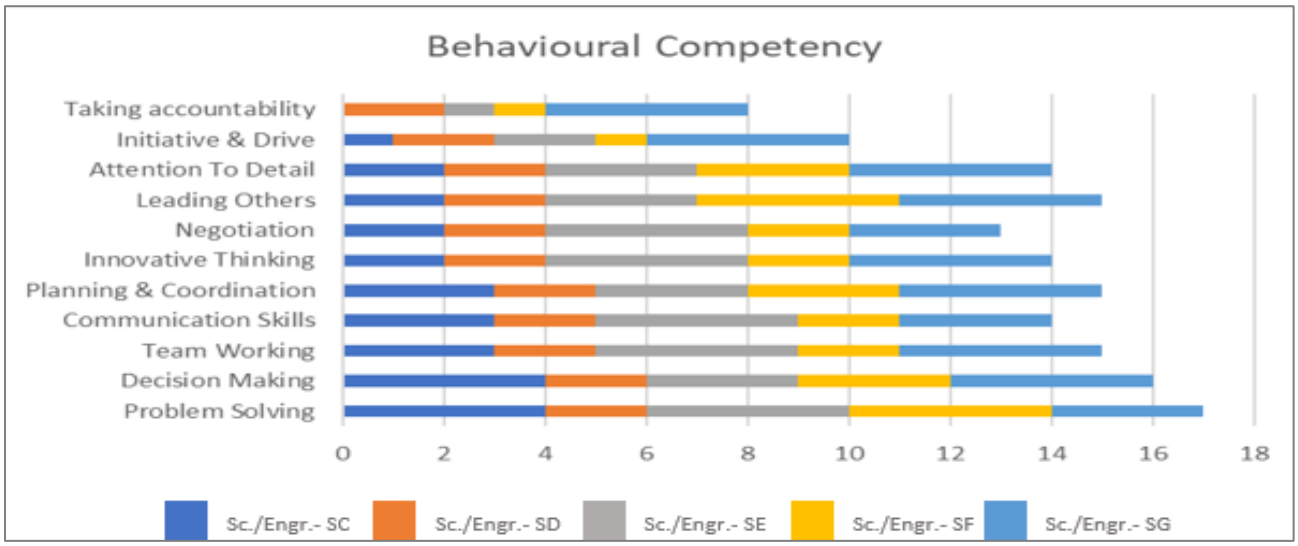


Figure 26: Survey Analysis of Behavioural Competencies[37]

5.1.2.1.1. Key findings

a. It was observed that top 11 competencies demanded by the scientists at ISRO were almost same across all levels. Skills like 'Taking Accountability' & 'Initiate & Drive', where the demand from Scientist/Engineer SE to SG is much higher than level of Scientist/Engineer SC & SD

b. Problem solving and Decision Making are the most demanded common competencies for scientists across ISRO centers.

c. "Taking accountability" as a skill is the most demanded at Scientist/Engineer SG, due to their leadership roles of a division or a project. On similar lines, skills like "Attention to detail", "leading others" and "Negotiation" are highly demanded from Scientist/Engineer SE to Scientist/Engineer SG, as their deliverables increase, and financial powers improve to a higher degree.

[37] Source: CBPO, ISRO

5.1.2.2. Functional Competency Analysis

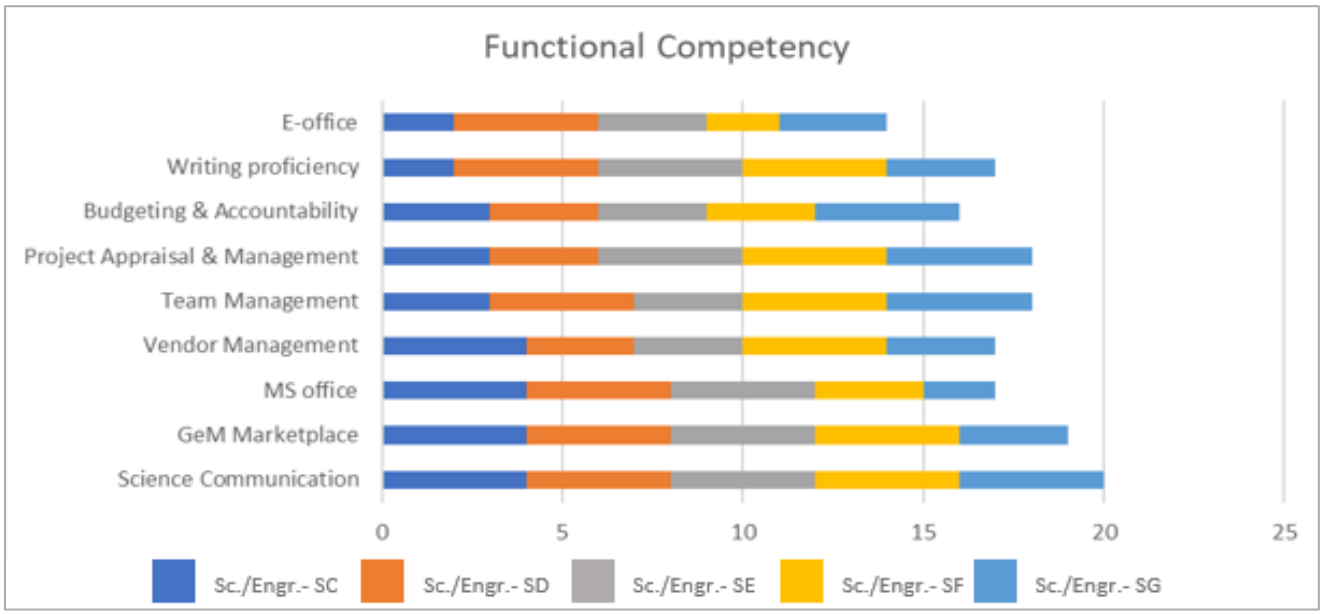


Figure 27: Survey Analysis of Functional Competencies[38]

The above chart represents the top nine competencies in demand under the functional skills domain.

5.1.2.2.1. Key findings

a. "GeM marketplace" and "Science Communication" form the highly demanded set of skills across all levels of scientists in ISRO. As scientists in a few divisions also have publishing research papers in reputed journals as their deliverable, writing proficiency also assumes equal weightage.

b. Competencies like "Budgeting & Accountability", "Project Appraisal & Management" and "Team Management" also have been in high demand, as elements like vendor, cost, procurement, and team management are distributed amongst all scientists in a division/project. Scientist/Engineer-SC and Scientist/Engineer-SD, also require "Team Management" training to manage technicians, Junior Technical Assistants etc.

c. Similarly, all scientists have communicated their need to learn desktop skills, MS office suite, E-office platform and writing proficiency – particularly to hone their technical writing skills.

[38] Source: CBPO, ISRO

5.1.3. Designation wise needs assessment for ISRO

Designation	Behavioural competencies (11)	Level	Functional competencies (09)	Level
Scientist/Engineer SG	Attention To Detail	L-2	E-office	L-2
	Communication Skills	L-2	Writing Proficiency	L-2
	Decision Making	L-2	Budgeting & Accountability	L-2
	Initiative & Drive	L-2	Project Appraisal & Management	L-1/L-2
	Innovative Thinking	L-2	Team Management	L-2
	Leading Others	L-2	Vendor Management	L-2
	Negotiation	L-1/L-2	MS Office	L-2
	Planning & Coordination	L-2	GeM Marketplace	L-2
	Problem Solving	L-2	Science Communication	L-2
	Taking accountability	L-2		
	Team Working	L-2		
Scientist/Engineer SF	Attention To Detail	L-2	E-office	L-2
	Communication Skills	L-2	Writing Proficiency	L-2
	Decision Making	L-2	Budgeting & Accountability	L-2
	Initiative & Drive	L-2	Project Appraisal & Management	L-1/L-2

Designation	Behavioural competencies (11)	Level	Functional competencies (09)	Level
	Innovative Thinking	L-2	Team Management	L-2
	Leading Others	L-2	Vendor Management	L-2
	Negotiation	L-1/L-2	MS Office	L-2
	Planning & Coordination	L-2	GeM Marketplace	L-2
	Problem Solving	L-2	Science Communication	L-2
	Taking accountability	L-2		
	Team Working	L-2		
Scientist/Engineer SE	Attention To Detail	L-1/L-2	E-office	L-2
	Communication Skills	L-2	Writing Proficiency	L-2
	Decision Making	L-1/L-2	Budgeting & Accountability	L-1/L-2
	Initiative & Drive	L-2	Project Appraisal & Management	L-1/L-2
	Innovative Thinking	L-2	Team Management	L-2
	Leading Others	L-2	Vendor Management	L-2
	Negotiation	L-2/L-3	MS Office	L-2
	Planning & Coordination	L-2/L-3	GeM Marketplace	L-2
	Problem Solving	L-2	Science Communication	L-2

Designation	Behavioural competencies (11)	Level	Functional competencies (09)	Level
	Taking accountability	L-1/L-2		
	Team Working	L-2		
Scientist/Engineer SD	Attention To Detail	L-1/L-2	E-office	L-2
	Communication Skills	L-1/L-2	Writing Proficiency	L-1/L-2
	Decision Making	L-1/L-2	Budgeting & Accountability	L-1
	Initiative & Drive	L-1/L-2	Project Appraisal & Management	L-1
	Innovative Thinking	L-1	Team Management	L-1/L-2
	Leading Others	L-1	Understanding of GeM	L-1/L-2
	Negotiation	L-1	MS Office	L-2
	Planning & Coordination	L-1	Vendor Management	L-1/L-2
	Problem Solving	L-1/L-2	Science Communication	L-1/L-2
	Taking accountability	L-1/L-2		
	Team Working	L-2		
Scientist/Engineer SC	Attention To Detail	L-1	E-office	L-1/L-2
	Communication Skills	L-1	Writing Proficiency	L-1
	Decision Making	L-1	Budgeting & Accountability	L-1

Designation	Behavioural competencies (11)	Level	Functional competencies (09)	Level
	Initiative & Drive	L-1	Project Appraisal & Management	L-1
	Innovative Thinking	L-1	Team Management	L-1
	Leading Others	L-1	Understanding of GeM	L-1/L-2
	Negotiation	L-1	MS Office	L-1/L-2
	Planning & Coordination	L-1	Vendor Management	L-1/L-2
	Problem Solving	L-1	Science Communication	L-1
	Taking accountability	L-1		
	Team Working	L-1/L-2		

5.1.4. Designation wise competency assessment at organizational level

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
1	Vikram Sarabhai Space Centre, Trivandrum &	Regular	B	Attention To Detail			A[40]	A	A
			B	Communication Skills					
			B	Decision Making			A	A	A

[39] Type: B: Behavioral; F: Functional; D: Domain
[40] Advanced

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
	Liquid Propulsion Systems Centre		B	Initiative & Drive					
			B	Innovative Thinking	B[41]		A		A
			B	Leading Others				A	A
			B	Negotiation			B		A
			B	Planning & Coordination			A		
			B	Problem Solving	B		A	A	
			B	Taking accountability					
			B	Team Working	B		A	A	A
			F	E-office		A	A		
			F	Writing Proficiency		A	A	A	
			F	Budgeting & Accountability	B				
			F	Project Appraisal & Management	B		A	A	A
			F	Team Management	B		A	A	A

[41] Basic

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Vendor Management				A	
			F	MS Office	A	A		A	
			F	GeM Marketplace	A		B	A	
			F	Science Communication	B		A	A	A
2.	**Space Applications Centre, Ahmedabad**	Regular	B	Attention To Detail	A				A
			B	Communication Skills			A		
			B	Decision Making	A				
			B	Initiative & Drive					
			B	Innovative Thinking	A		A		A
			B	Leading Others					A
			B	Negotiation					
			B	Planning & Coordination					
			B	Problem Solving	A		A		
			B	Taking accountability					A
			B	Team Working			A		A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	E-office	A				A
			F	Writing Proficiency	A	A	A		A
			F	Budgeting & Accountability	B				
			F	Project Appraisal & Management		A	A	A	
			F	Team Management	A	A		A	A
			F	Vendor Management					
			F	MS Office					
			F	GeM Marketplace	A	A		A	A
			F	Science Communication	A	A	B	A	A
3.	U.R. Rao Satellite Centre, Bengaluru	Regular	B	Attention To Detail		A	A	A	A
			B	Communication Skills		A	A	A	
			B	Decision Making	A	A	A	A	A
			B	Initiative & Drive					A
			B	Innovative Thinking		A	A	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			B	Leading Others		A		A	
			B	Negotiation		A			A
			B	Planning & Coordination		A	A	B	A
			B	Problem Solving		A	A		A
			B	Taking accountability		A			A
			B	Team Working		A	A	A	A
			F	E-office			A	A	
			F	Writing Proficiency	A	A	A	A	
			F	Budgeting & Accountability	A		A		A
			F	Project Appraisal & Management		A	A	A	A
			F	Team Management		A	A	A	A
			F	Vendor Management		A		A	A
			F	MS Office		A	A	A	
			F	GeM Marketplace		A	A	A	

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Science Communication		A	A	A	A
4.	**Satish Dhawan Space Centre, Sriharikota**	Regular	B	Attention To Detail				A	A
			B	Communication Skills	A	A	A	A	A
			B	Decision Making		A	A	A	A
			B	Initiative & Drive		A		A	A
			B	Innovative Thinking		A	A	A	A
			B	Leading Others	A		A	A	A
			B	Negotiation	A		A	A	
			B	Planning & Coordination			A	A	A
			B	Problem Solving		A	A	A	A
			B	Taking accountability		B			
			B	Team Working			A		A
			F	E-office	A		B	A	A
			F	Writing Proficiency		A		A	A
			F	Budgeting & Accountability				A	

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Project Appraisal & Management	A		B	A	
			F	Team Management	A	A	A	A	A
			F	Vendor Management	B	A	B	A	
			F	MS Office		A			
			F	GeM Marketplace	A	A	B	A	A
			F	Science Communication	A	A		A	A
5.	**Human Space Flight Centre (HSFC)**	Regular	B	Attention To Detail	B		A	A	
			B	Communication Skills	B		A	A	
			B	Decision Making	A		A	A	A
			B	Initiative & Drive	B		B		
			B	Innovative Thinking	B	A			
			B	Leading Others	B		B		
			B	Negotiation	B	B	B	B	A
			B	Planning & Coordination	B	A	A	B	B

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			B	Problem Solving	B	A	A		
			B	Taking accountability	B		B		
			B	Team Working	A	A	A	A	
			F	E-office	A		A		
			F	Writing Proficiency	A	A	A	A	A
			F	Budgeting & Accountability	B	B	B	B	B
			F	Project Appraisal & Management	B	B	A	A	A
			F	Team Management	A	A	A	A	
			F	Vendor Management	B	A	B		
			F	MS Office	B		B		
			F	GeM Marketplace	A		B		A
			F	Science Communication	A		A		
6.	**ISRO Telemetry,**	Regular	B	Attention To Detail	B	B	A	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
	Tracking and Command Network (ISTRAC)		B	Communication Skills	B	A	A	A	B
			B	Decision Making	A	A	A	A	A
			B	Initiative & Drive	B	B	B	B	A
			B	Innovative Thinking	B	A	A	A	A
			B	Leading Others	B	B	B	A	A
			B	Negotiation	B	B	B	B	
			B	Planning & Coordination	B	A	A	B	B
			B	Problem Solving	B	A	A	A	A
			B	Taking accountability	B	B	B	B	
			B	Team Working	A	A	A	A	A
			F	E-office	A	B	A	A	A
			F	Writing Proficiency	A	A	A	A	A
			F	Budgeting & Accountability	B	B	B	B	B
			F	Project Appraisal & Management	B		A	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Team Management	A	A	A	A	A
			F	Vendor Management	B	A	B	A	B
			F	MS Office	B	A	B	A	B
			F	GeM Marketplace	A	A	B	A	A
			F	Science Communication	A	A	A	A	A
7	**Master Control Facility (MCF)**	Regular	B	Attention To Detail	B	B	A	A	A
			B	Communication Skills	B	A	A	A	B
			B	Decision Making	A	A	A	A	A
			B	Initiative & Drive	B	B	B	B	A
			B	Innovative Thinking	B	A	A	A	A
			B	Leading Others	B	B	B	A	A
			B	Negotiation	B	B	B	B	A
			B	Planning & Coordination				B	
			B	Problem Solving	B	A	A	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			B	Taking accountability	B	B	B	B	
			B	Team Working	A	A	A	A	A
			F	E-office	A	B	A	A	A
			F	Writing Proficiency	A	A	A	A	
			F	Budgeting & Accountability	B	B	B	B	B
			F	Project Appraisal & Management	B	B	A	A	A
			F	Team Management	A	A	A	A	A
			F	Vendor Management	B	A	B	A	B
			F	MS Office	B	A	B	A	B
			F	GeM Marketplace	A	A	B	A	A
			F	Science Communication	A	A	A	A	A
8	**ISRO Inertial Systems Unit (IISU)**	Regular	B	Attention To Detail	B	B	A	A	A
			B	Communication Skills	B	A	A	A	B

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			B	Decision Making			A		
			B	Initiative & Drive	B	B	B	B	A
			B	Innovative Thinking	B	A	A	A	A
			B	Leading Others	B	B	B	A	A
			B	Negotiation	B	B	B	B	A
			B	Planning & Coordination	B	A	A	B	B
			B	Problem Solving	B	A	A	A	A
			B	Taking accountability	B	B	B	B	A
			B	Team Working	A	A	A	A	A
			F	E-office	A	B	A	A	A
			F	Writing Proficiency	A	A	A	A	A
			F	Budgeting & Accountability	B	B	B	B	B
			F	Project Appraisal & Management	B	B	A	A	A
			F	Team Management	A	A	A	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Vendor Management	B	A	B	A	B
			F	MS Office	B	A	B	A	B
			F	GeM Marketplace	A	A	B	A	A
			F	Science Communication	A	A	A	A	A
9	National Remote Sensing Centre (NRSC)	Regular	B	Attention To Detail	A				A
			B	Communication Skills			A	A	
			B	Decision Making	A				
			B	Initiative & Drive					A
			B	Innovative Thinking	A		A	A	
			B	Leading Others					A
			B	Negotiation				B	A
			B	Planning & Coordination					
			B	Problem Solving	A		A		
			B	Taking accountability					
			B	Team Working			A		

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	E-office	A			A	
			F	Writing Proficiency	A	A	A		A
			F	Budgeting & Accountability	B				B
			F	Project Appraisal & Management		A	A		
			F	Team Management	A	A			
			F	Vendor Management					B
			F	MS Office					
			F	GeM Marketplace	A	A			A
			F	Science Communication	A	A	B		A
10	ISRO Propulsion Complex	Regular	B	Attention To Detail	A	B	B	B	B
			B	Communication Skills	A	A	B	B	B
			B	Decision Making	A	A	A	A	A
			B	Initiative & Drive					
			B	Innovative Thinking	A	A	A	B	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			B	Leading Others	A	B	A	A	A
			B	Negotiation					
			B	Planning & Coordination				B	B
			B	Problem Solving	A	A	A	A	B
			B	Taking accountability		B		B	B
			B	Team Working		B	B	B	B
			F	E-office	A	B	A	B	A
			F	Writing Proficiency	A	A	A	A	A
			F	Budgeting & Accountability			B	B	B
			F	Project Appraisal & Management			B	B	B
			F	Team Management	A	A	A	A	A
			F	Vendor Management	B	B	B	B	B
			F	MS Office	B	A	B	B	B
			F	GeM Marketplace	A	A	B	A	A

#	Organization	Training Type	Competency Gaps		Training Level basis positions				
			Type [39]	Area/ Name	Scientist/ Engineer-SC	Scientist/ Engineer-SD	Scientist/ Engineer-SE	Scientist/ Engineer-SF	Scientist/ Engineer-SG
			F	Science Communication	B	A	A	B	B

*A is for advanced Level of training and “B” is for basic level of training required

*The level of training required was not available for all institutes. The methodology followed to come up with the levels required in such cases involved analyzing the number of scientists who had assigned the advanced level for each designation.

5.2. Competency Mapping for Technicians & Technical/Scientific Assistants

5.2.1. Competency Mapping Process

The competency mapping exercise was also done for the technicians of the ISRO centers. The different skill sets across each role, that need to be upgraded were identified across three categories including Domain/sectoral knowledge requirements, functional competency requirements and Behavioral competency requirements.

Various institutes and units of ISRO were covered for the capacity needs assessment of the Technicians and Technical/ Scientific Assistants. These have been detailed below-

S.No.	Organization	Number of staff covered in CNA
1.	Vikram Sarabhai Space Centre	863
2.	U.R. Rao Satellite Centre	76
3.	Satish Dhawan Space Centre	787
4.	Space Applications Centre	344
5.	ISRO Inertial Systems Unit	109
6.	Master Control Facility	38
7.	ISRO Propulsion Complex	124
8.	National Remote Sensing Centre	151
9.	ISRO Telemetry, Tracking and Command Network	17
10.	Human Space Flight Centre	195
11.	Liquid Propulsion Systems Centre	424
	TOTAL	~3910

Table 7: Coverage of capacity needs of Technicians and Technical/ Scientific Assistants

For the skill mapping and training need requirements analysis the following methodology was followed-

a. First, the institute wise data was studied
b. The competencies were then mapped to Functional, Behavioral and Domain competencies
c. The identified functional and behavioral competencies for each institute, were collated and a combined list for the whole department was made
d. For the domain competencies-
    - The competencies common across multiple roles were listed for each institute
    - For analysis at the department level, the domain competencies that were common across the largest four centers (as shown below) have been identified

S.no	Centers with largest strength in DoS
1	Vikram Sarabhai Space Centre Thiruvananthapuram
2	U R Rao Satellite Centre (URSC), Bengaluru
3	Satish Dhawan Space Centre, Sriharikota
4	Space Applications Centre, Ahmedabad

Table 8: Four largest centers of DoS

The institute wise analysis of the competencies has been given in the following section.

5.2.2. Institute-wise competency analysis

5.2.2.1. Vikram Sarabhai Space Centre (VSSC)

The functional, behavioral and domain competencies that need to be upgraded through trainings have been mentioned in the following table-

Competency	Competency Gaps
Functional	i. MS Office ii. Safety Training iii. Maintenance of Equipment iv. Basic training on ISO standards. v. Awareness to administrative activities including budget and fund management vi. Technical writing skill vii. Science communication skill
Domain	i. Earthing ii. Soldering iii. High pressure safety iv. Auto Cad v. CMM usage and programming techniques
Behavioral	i. Development of Communication Skill. ii. Personality development iii. Behavioral science

Table 9: Competency Mapping[42]

5.2.2.2. U R Rao Satellite Centre (URSC)

The functional, behavioral and domain competencies that need to be upgraded through trainings have been mentioned in the following table-

[42] Source: CBPO, ISRO, PwC Analysis

Competency	Competency Gaps
Functional	i. Usage of Microsoft Office tools. ii. Spoken English Class. iii. Awareness of cleanroom environment and practices
Domain	i. Linux operating systems ii. Soldering techniques iii. LabVIEW
Behavioral	i. Communication Skills

Table 10: Competency Mapping[43]

5.2.2.3. Satish Dhawan Space Centre (SDSC)

The functional and domain competencies that need to be upgraded through trainings have been mentioned in the following table-

Competency	Competency Gaps
Functional	i. Data Handling, Security & protection ii. English communication and public speaking iii. Basic Computer training
Domain	i. Basics of Electrical Engineering ii. PCB Layout preparation software tool iii. Soldering iv. Networking Basics v. 3D Building Modelling using latest software packages vi. First aid training vii. Safety trainings

Table 11: Competency Mapping[44]

5.2.2.4. Space Applications Centre (SAC)

The key domain competencies that need to be upgraded through trainings have been mentioned in the below table-

Competency	Competency Gaps

[43] Source: CBPO, ISRO, PwC Analysis
[44] Source: CBPO, ISRO, PwC Analysis

Domain	i. Fabrication Processes for Different Connectors ii. EMI/EMC iii. CAD Tools for PCB Layout Design
Functional	i. MS Office Applications ii. Data Management

Table 12: Competency Mapping

5.2.2.5. ISRO Propulsion Complex (IPRC)

The key domain competencies that need to be upgraded through trainings have been mentioned in the below table-

Competency	Competency Gaps
Domain	i. CNC programming ii. 3D CMM Skill iii. Advanced Welding process

Table 13: Competency Mapping[45]

5.2.2.6. ISRO Inertial Systems Unit (IISU)

The functional and domain competencies that need to upgrade through trainings have been mentioned in the below table

Competency	Competency Gaps
Functional	i. Awareness about recent guidelines for Inspection of electronic components ii. Basic Computer knowledge
Domain	i. Precision assembly, ii. CNC programming iii. CAD drafting and 3D modelling iv. Basic AutoCAD Knowledge v. LabVIEW software vi. Soldering techniques

Table 14: Competency Mapping[46]

5.2.2.7. Master Control Facility (MCF)

The functional, behavioral and domain competencies that need to be upgraded through trainings have been mentioned in the below table-

[45] Source: CBPO, ISRO, PwC Analysis
[46] Source: CBPO, ISRO, PwC Analysis

Competency	Competency Gaps
Functional	i. Safety in material handling ii. Fire Safety and First Aid iii. Computer Programming iv. Data management System
Behavioral	i. Middle level management training ii. Communication skills
Domain	i. Basic Electrical and electronics control systems ii. Maintenance Engineering specialized training program iii. Electrical Safety, lifesaving techniques iv. Earthing practices v. Measuring techniques vi. Latest Soldering Technique

Table 15: Competency Mapping

5.2.2.8. Liquid Propulsion Systems Centre (LPSC)

The key functional, behavioral and domain competencies that need to be upgraded through trainings have been mentioned in the below table:

Competency	Competency Gaps
Functional	i. Spoken English ii. MS Office iii. Writing proficiency
Behavioral	i. Commitment to the Organization ii. Organizational Awareness iii. Problem Solving iv. Team Working
Domain	i. AutoCAD ii. Wiring, soldering & related works iii. Safe practices and First aid

Table 16: Competency Mapping

5.2.2.9. National Remote Sensing Centre (NRSC)

The key functional, behavioral and domain competencies that need to be upgraded through trainings have been mentioned in the below table-

Competency	Competency Gaps
Functional	i. Microsoft Office ii. Data Management System iii. Computer Skills
Behavioral	i. Communication Skills
Domain	i. Electrical Safety & QA ii. MATLAB iii. AutoCAD iv. Python v. Operating systems and Linux Programming vi. Adobe

Table 17:Competency Mapping[47]

5.2.2.10. Human Space Flight Centre (HSFC)

The key functional competencies that need to be upgraded through trainings have been mentioned in the below table-

Competency	Competency Gaps
Functional	i. PCB Design and Fabrication ii. MIC Soldering and Fabrication

Table 18:Competency Mapping[48]

[47] Source: CBPO, ISRO, PwC Analysis
[48] Source: CBPO, ISRO, PwC Analysis

5.2.2.11. ISRO Telemetry Tracking and Command Network (ISTRAC)

The key functional and domain competencies that need to be upgraded through trainings have been mentioned in the below table-

Competency	Competency Gaps
Functional	i. Database Administration ii. Website design and development
Domain	i. SMD Soldering ii. PCB design & analysis HV testing Soldering

Table 19:Competency Mapping[49]

[49] Source: CBPO, ISRO, PwC Analysis

5.2.3. Overview of Competency Assessment for Technical Staff

Functional	Behavioral	Domain
MS Office	Communication Skills	Earthing
Maintenance of Equipment	Personality development	Soldering
Budget and fund management	Behavioral science	Auto Cad
Technical writing skill	Project Management	Safety Training including fire safety
Science communication skill	Commitment to the Organization	First Aid
Data Management, Security & protection	Organizational Awareness	CNC programming
Basic Computer training	Problem Solving	CMM usage and programming techniques
Computer Programming language	Team Working	LabVIEW
Procurement	Conflict Solving Strategies	Operating systems and Linux Programming
Basic training on ISO standards	Networking skills	PCB Design and Fabrication

Figure 28: Snapshot of competency assessment of Technical Staff

5.2.4. Functional Competency Analysis

5.2.4.1. Key findings

- It was observed that the top functional competencies demanded by the technicians of the department were MS Office, Spoken English Class, Technical writing skill and Science communication skill

5.2.5. Behavioral Competency Analysis

5.2.5.1. Key findings

- It was observed that the top competency demanded by the technicians of the department was Communication skills
- Management Development, Team building and problem solving are further most in demanded competencies for scientists across the centers
- Other behavioral competencies mentioned include conceptual thinking, conflict solving strategies, consultation & consensus building, problem solving, decision making and Delegation

5.2.6. Domain Competency Analysis

5.2.6.1. Key observations

- It was observed that the top domain competencies demanded by the technicians of the department in the four largest institutes were Earthing, Soldering and AutoCAD.
- Other domain competencies that were common across these institutes were Safety training, First aid training, CNC programming, CMM Usage, LabVIEW, Operating systems, and PCB Design

6. Supply Analysis - Training Interventions

6.1. Interventions for Scientific Staff

6.1.1. Approach for identification of interventions

After the identification of the competencies and mapping across all the levels of the department, we start the process of identifying agencies and institutes to address the derived requirements at both individual and organizational level.

The following table provides the step wise process of the supply analysis undertaken by CBC in collaboration with STI-CB Cell.

Sl. No	Steps	Sub-steps	Outcome	Approval
1	Gap analysis (Gap in supply of interventions)	Study and map existing programs in demand to needs identified; Courses from the department that can be used for our purpose and gaps in supply thereof; Quality assessment of the course - i. Define parameters of quality ii. Process to assess quality	1. List of courses that can be onboarded 2. Courses that need to be digitized 3. Courses that need to be curated from scratch	Sign off from departments
2	Identify SME/Course providers	Identify type of intervention: i) SME/Course providers ii) Digitization agency Identifying third parties for quality assessment of the course	Recommendation to Department for the following: i) Modules for the courses identified ii) Suggested list government or non-government SME	Sign off from department
3	Intervention rollout	Identify target population for rollout Draft Proposal including: a. Funding b. Timeline c. Cost d. Logistics details; Onboard an Impact	1. Finalize partner and corresponding interventions 2. Final proposal for course creation and impact assessment	Sign off from CBC and department

Sl. No	Steps	Sub-steps	Outcome	Approval
		assessment agency (plan - baseline and endline) Onboarding of partner agencies for interventions - through CBC or Department		

Table 20: Supply analysis undertaken by CBC[50]

6.1.2. Key observations

- Based on the identified competencies by both junior and senior scientists/engineers of ISRO, the CBC team recommended and mapped specific courses for each of these competencies.
- Upon consultation with various subject matter experts, research institutes and business schools CBC team came across noteworthy recommendations for ISRO, which have been explained in the following sections.
- With a two-pronged approach catering to the needs of both Junior and senior cadre scientists, a Science and technology induction and leadership program is proposed, to be pursued with relevant institutes offering targeted capacity building programs.

6.1.3. Mapping of courses

Based on the data that was received from 10 ISRO centers (ANNEXURE) and in-person workshops conducted at 4 centers (mentioned in Demand Analysis), a list of competencies was derived and deliberated upon. The competencies were categorized as behavioural and functional.

The Courses will be mapped to Level 1 to Level 4 based on their duration, mode and content which will ensure that specific department needs are catered to for the Competencies.These have been detailed in th below diagram -

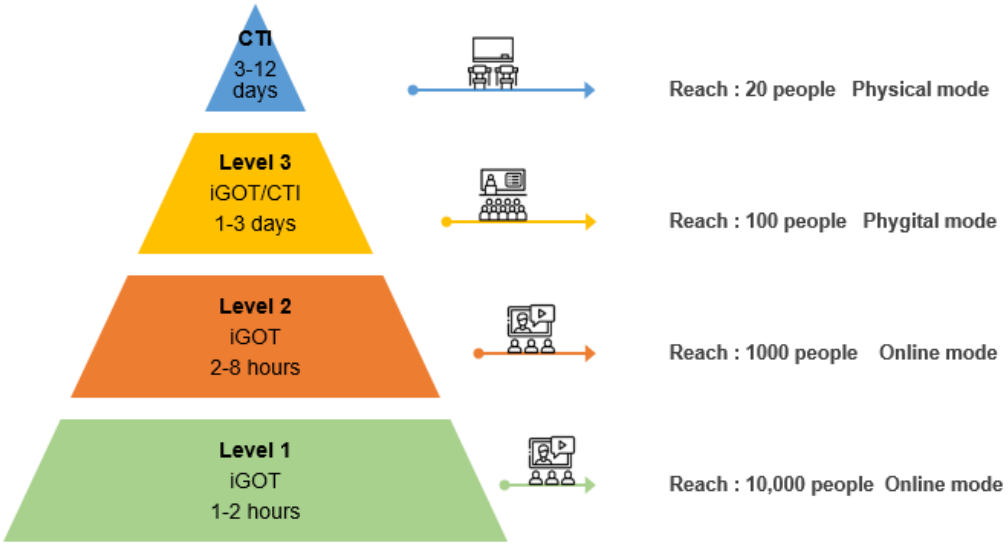


Figure 29: Level wise division and impact of courses

[50] Source: CBPO, ISRO

After collating data from ISRO centers, two common training modules were proposed for all the scientists in ISRO namely, a) Leadership Module and b) Induction Module.

6.1.3.1. Leadership Module

This module has been developed to enhance individual as well as institutional capacity. The target audience for the training will be senior Scientist/Engineer at SE, SG and SF levels. The objective is to create leaders who can compete with global R&D standards in Science and Technology. Some of the skills that are being captured under this module include - Project Management, Science Diplomacy, Science Communication, Design Thinking, Networking, Team Building, etc.

6.1.3.2. Induction Module

The objective for this module is create a common induction training for incoming scientists. The expected goal is to make them aware of the specific standards and requirements of scientific research and administration. The modules for this program will include subjects like: Design Thinking, Procurement, History of Science in India, Code of Conduct Rules.

The following table represents the list of institutes that proposed their programs for the respective modules. After comparing each program and their deliverables, a select number of institutes will be chosen to implement programs by ISRO-CBPO.

Course	Institute	Program Module
Leadership	IIM Calcutta	Program in Leadership Management
	CCL (Center for creative leadership)	Core Leadership Skills
	ISB - Hyderabad	Leadership and Business value creation for S&T personnel - Leading high-performance teams, innovation and change leadership, Design thinking, Project management, Effective communications, big picture thinking
	CTIER & Ahmedabad University	Building science leaders in India

Course	Institute	Program Module
Induction	CSIR and C&K	Design thinking, Procurement, GFR - 2017, Central conduct code, History of Science in India
	IIM Ahmedabad	Design Thinking, Behavioural Insights, and Future Thinking
	IIM Vizag	Strategy and policy skills; System skills; Soft skills; Science for Societal relevance

Table 21: Mapping of Courses[51]

[51] Source: CBPO, ISRO

6.1.3.3. Management Development Program (MDP)

After completing the exercise of identifying the in-demand competencies and potential SME and institutes, ISRO-CBPO curated the MDP that will cater to overall management needs for the scientific personnel at all ISRO Centers. These modules shall be delivered in-person in engagement with the partner institute with dedicated access to faculty and other knowledge resources, as agreed.

The following table provides the outline of potential modules for the program and suggestive list of institutes was created to explore their existing programs and courses as follows:

Behavioural Competency	Agencies	Course
Conceptual Thinking	1. IIPA	Training Course - Conceptual Thinking
Decision Making	1. IIM Vizag	Foundation course (M3) - Leadership and decision making
	2. Graduate school of Stanford business	The Brain and Guts of Decision Making
Conflict resolving strategies (Consultation, Consensus Building, Negotiation)	1. ICAR-NAARM	Human Resource Management; Stakeholder Management
	2. CTIER	Building Science Leaders in India - Conflict Management
	3. XLRI	In Company Programs - Contract Management & Arbitration
Developing Others	1. IIM Vizag	Foundation course (M3) - Leadership and decision making
	2. ICAR-NAARM	Human Resource Management; Stakeholder Management
	3. CTIER	Building Science Leaders in India - Inter & Intra-personal relationships; Team building; Organizational behaviour
Delegation	1. XLRI	In Company Programs - Leadership effectiveness & development
	2. ICAR-NAARM	Human Resource Management
Innovative Thinking + Strategic Thinking + Design thinking (Functional)	1. ISB – Hyderabad	Leadership & Business Value Creation for Science & Technology Personnel (Proposal) - Design Thinking
	2. Indian School of Public Policy	Design Thinking
	3. IIM Vizag	Foundation course (M2) - Design Thinking

Behavioural Competency	Agencies	Course
	4. CTIER	Building Science Leaders in India - Innovative thinking; Design thinking & management
Motivating others	1. ICAR-NAARM	Human Resource Management
Networking skills	1. CTIER	Building Science Leaders in India - Networking skills
People Management	1. ICAR-NAARM	Human Resource Management
	2. CTIER	Building Science Leaders in India
Organizational Awareness	1. ICAR-NAARM	Human Resource Management

Table 22: Mapping of Courses[52]

Functional Competency	Agencies	Course
Project Management - (Cost Management, Time Management, Change Management, Procurement, GFR, Budget & Accountability, Data analysis and Interpretation, Financial budgeting & management, Knowledge & Technology Transfer, PFMS, Procurement & Tendering, Program management, Project Appraisal & Management, Quality Management, Risk Analysis & Management, Supply chain management)	1. ISRO	Customized
	2. XLRI	Executive Development Program in Project Management for Senior Professionals
	3. ISB	Leadership & Business Value Creation for Science & Technology Personnel (Proposal) - Project Management
	4. CTIER	Building Science Leaders in India - Project Management
Management Development Program by Mr. Adhesh Jain	Online Mode	Duration-5 days
Data management - Data analysis and Interpretation; Documentation; E-office	1. XLRI	In Company Programs - Data based decision making
	2. Coursera	Data base management
IPR	1. Udemy	Certificate Course in IPR
	2. Institute of Good Manufacturing Practices India	Executive Diploma in Pharmaceutical Intellectual Property Rights
Knowledge Management	1. IIM Vizag	Foundation course (M2) - Knowledge Management

[52] Source: CBPO, ISRO

Functional Competency	Agencies	Course
Procurement (Budgeting, GFR 2017, IFD framework, PFMS, Procurement & Tendering, Tender Writing, Project Appraisal & Management, Vendor Management, GeM Marketplace)	1. AJNIFM	Customized course for ISRO scientists and admin staff with specific focus on ISRO procurement processes.
Management Development Program	1. HAL Management Academy 2. XIME 3. IIM Bangalore 4. ISB- Hyderabad	Customized course for ISRO scientists and admin staff with specific focus on general management and other necessities.

Table 23: Mapping of Courses[53]

[53] Source: CBPO, ISRO

6.1.3.4. Courses mapped to Domain Competencies

Hundred key domain competencies were analyzed for the Scientist/ Engineer staff of ISRO. These have been grouped into the following 16 groups mentioned below-

S.No.	Competency Group	Number of competencies in the Group
1.	Structure, material and device Design	12
2.	System Engineering and Design	10
3.	Processing and Process Analytics	6
4.	Data Analysis and Management	6
5.	Product Development	5
6.	Manufacturing Techniques	5
7.	AI and ML	4
8.	Computational Dynamics	4
9.	Emerging technologies	4
10	Safety and Disaster Management	4
11.	Data Acquisition and Modelling	3
12.	Material Handling, Inventory and Technology	3
13.	Optimization Techniques	3
14.	Procedures and Techniques	2
15.	Construction and Building Methods	2
16.	Others	27
	Total	100

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Optimal Control and Guidance	Optimal Control, Guidance and Estimation	IISc on NPTEL	Online	Self-paced	Free	https://archive.nptel.ac.in/content/syllabus_pdf/101108057.pdf
AutoCAD	CERTIFICATE IN AUTOCAD & 3D MAX	C-DAC	Online	12 hours	Paid	https://www.cdac.in/index.aspx?id=edu_pace_ccrs
	AutoCAD 2D and 3D	IIT-Kanpur	Online	Self-paced	INR 2966	https://ict.iitk.ac.in/product/autocad-2d-and-3d/
Additive Manufacturing	Advances in Material Processing and Additive Manufacturing	IIITDM Jabalpur	Online	10 days	Paid	https://eictacademy.meity.gov.in/course-iiitdmj/
	Digital Manufacturing and Smart Factories	IISc	Hybrid	-	₹3,10,000	https://iisc.talentsprint.com/dmsf/#curriculum
Machine Learning	Machine Learning	IIT-Kanpur	Online Live + Classroom in Bangalore	120 Hours	INR 16900	https://ifacet.iitk.ac.in/product/machine-learning-2/
AI and ML with emphasis on Big Data Analytics	Advanced Certification in Big Data Analytics	IIT-Guwahati (With IBM)	Online-Live (includes 2 day immersion program at IIT-G)	231 Hours of live training 182 Hours of Self-paced video 300 Hours of Guided projects	INR 99,009	https://intellipaat.com/big-data-analytics-course-eict-iit-guwahati/
	Digital Manufacturing and Smart Factories	IISc	Hybrid	-	₹3,10,000	https://iisc.talentsprint.com/dmsf/#curriculum
Antenna Systems Design	Fundamentals of Antenna Trends	IIT-Guwahati	Online	40 hours	Not Available	https://eictacademy.meity.gov.in/courses-iitg/

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
	Advanced Antennas Design using CST	Udemy	Online	5 hours	650	https://www.udemy.com/course/advanced-antennas-design-using-cst/
AR, VR & Experiential Technology (XR)	Specialized Training Program in Augmented and Virtual Reality	C-DAC	Online	1 Week (05 days)	Could not find	https://www.cdac.in/index.aspx?id=edu_et_E_IPC_DACMohali
	Digital Manufacturing and Smart Factories	IISc	Hybrid	-	₹3,10,000	https://iisc.talentsprint.com/dmsf/#curriculum
CCNA: Cisco certified Network Administrator	CCNA 2020 200-125 Video Boot Camp	Udemy	Online	62.5	INR 800 (Additionally 200-301 CCNA exam – 300 USD per attempt)	https://www.udemy.com/course/ccna-on-demand-video-boot-camp/, https://www.uninets.com/ccna-exam-fees/
Chemometric Data Analysis	Big Data Management & Comprehensive Analysis	C-DAC	Online	This program is sponsored by DST (Govt. of India) and no fee is charged from the participants. Before accepting the nominations, the same shall be got vetted by Training Cell, DST		https://www.cdac.in/index.aspx?id=edu_et_dst_BigData
Chromatography	Chromatography Techniques Certification Course	Biotechnical	Online	Self-paced	1100	https://stores.biotecnika.org/products/chromatography-techniques-certification-course
Climate Data Analysis	Big Data Management & Comprehensive Analysis	C-DAC	Online	This program is sponsored by DST		https://www.cdac.in/index.aspx?id=edu_et_dst_BigData

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
				(Govt. of India) and no fee is charged from the participants		
Cloud Computing	Cloud Computing using Microsoft Azure	IIT-Kanpur	Online Live	100 hours	INR 10500	https://ifacet.iitk.ac.in/product/cloud-computing-using-microsoft-azure/
	Cloud Computing using AWS	IIT-Kanpur	Classroom-available	100 hours	INR 12900	https://ifacet.iitk.ac.in/product/cloud-computing-using-aws/
	Advanced Certification in Cloud Computing & DevOps	IIT Roorkee	Online	187 hours	Monthly subscription	https://intellipaat.com/cloud-computing-certification-program-iit-roorkee/
Computational Fluid Dynamics	Computational Fluid Dynamics	IIT Madras	Online	12 weeks	Free	https://onlinecourses.nptel.ac.in/noc20_ch05/preview
Computational Mechanics	COMPUTATIONAL CONTINUUM MECHANICS	NPTEL	Online	12 weeks	Free	https://archive.nptel.ac.in/content/syllabus_pdf/112103296.pdf
Computational Electro magnetics	Computational Electromagnetics	NPTEL	Online	12 weeks	Free	https://onlinecourses.nptel.ac.in/noc21_ee91/preview
Computations Gas Dynamics	Advanced Gas Dynamics - Video course	NPTEL	Online	55 hours	Free	https://archive.nptel.ac.in/content/syllabus_pdf/112106056.pdf
Cyber Security	Advance Cyber Security and Computer Forensics	IIT-Kanpur	Online	10 Hours	422	https://ifacet.iitk.ac.in/courses/advance-cyber-security-and-computer-forensics/
	Cyber Security	C-DAC	Online	26 weeks (3 hours/day)	INR 23,600	https://www.cdac.in/index.aspx?id=edu_et_CyberSecurity

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
	Online Training Program on Management of Digital Hygiene: Staying Secure in Cyber Space for the Scientists & Technologists working in Government sector	C-DAC	Online	5-days	This program is sponsored by DST and no fee is charged from the participants.	https://www.cdac.in/index.aspx?id=edu_et_BrochureDigitalHygiene
	The Complete Cyber Security Course	Udemy	Online	12.5 hours	3700	https://www.udemy.com/course/network-security-course/
Design Thinking	Research Methodologies and Design thinking for Professional Career	IITDM-Jabalpur	Online	6 days	Paid	https://eictacademy.meity.gov.in/course-iiitdmj/
	Mastering Design Thinking	Stanford	Self-Paced Online	3 weeks (6/8 hours a week)	USD 3300	https://executive.mit.edu/course/mastering-design-thinking/a056g00000URaa4AAD.html
Digital NDT Techniques	Theory and Practice of Non Destructive Testing	NPTEL	Online	Self-paced	Free	https://onlinecourses.nptel.ac.in/noc21_mm02/preview
Disaster mitigation tool development	Training program on Mainstreaming Disaster Management	Gujarat Institute of Disaster Management (GIDM)	Offline	3 day workshop		https://saarc-sdmc.org/training-program-mainstreaming-disaster-management-infrastructure-sector
Electro Optical PCB design	Advanced Hardware and PCB Design Masterclass	Udemy	Online	23 hours	550	https://www.udemy.com/course/advanced-hardware-design-course/

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Finite Element Analysis	Basics of Finite Element Analysis-I	NPTEL	Online	8 weeks self-paced	Free	https://nptel.ac.in/courses/112104193
Flight Dynamics	Flight dynamics I	By IIT Madras on NPTEL	Online	Self-paced	free	https://nptel.ac.in/courses/101106041
Fluoroscopy	Radiation Protection in Fluoroscopy Guided Interventional Procedures	IAEA	Online	-	Paid	Link
Green Building Concepts	Introduction to green buildings	Udemy	Online	Self-paced	INR 650	https://www.udemy.com/course/intro-green-buildings/
Hyperspectral & SAR Data Analysis	Big Data Management & Comprehensive Analysis	C-DAC	Online	This program is sponsored by DST (Govt. of India) and no fee is charged from the participants. Before accepting the nominations, the same shall be got vetted by Training Cell, DST		https://www.cdac.in/index.aspx?id=edu_et_dst_BigData
Image Processing	Digital Image Processing using MATLAB	IIT-Roorkee	Online	4O hours		https://eictacademy.meity.gov.in/courses-iitr/
	Digital Image Processing	IIT-K on NPTEL	Online	12 weeks	1free	https://onlinecourses.nptel.ac.in/noc19_ee55/preview
Industry 4.0 & Implementation	Digital Manufacturing and Smart Factories	IISc	Hybrid		₹3,10,000	https://iisc.talentsprint.com/dmsf/#curriculum
	INDUSTRY 4.0	TATA Digi-Shala		6 hours	INR 410	https://capabilitydevelopment.org/Coursedesc/ioc/Industry-4.0

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Instrumentation/ Measurement Techniques for Flow & Heat Transfer	Two phase flow and heat transfer	NPTEL	Online	Self-paced	Free	https://onlinecourses.nptel.ac.in/noc20_me32/preview
Intelligent Space Vehicle Design	Design of Space Launch Vehicles	AIAA	Online	30 hours	Not available	http://aiaa.mycrowdwisdom.com/diweb/catalog/item?id=8376380
Lattice Composite Structure Design	Mechanics of foams and lattice materials	IIT Hyderabad	Offline	9 days	16000	https://people.iith.ac.in/gian/img/Brochure-Dr.%20Syed.pdf
Material Inventory & Control	Master Course in Inventory Management and Inventory Control	Udemy	Online	1 hour 15 minutes		https://www.udemy.com/course/materials-management-inventory-control/
Mechatronics	Mechatronics, EMS, and Micro fabrication	IITDM-Jabalpur	Online	40 hours	Paid	https://eictacademy.meity.gov.in/course-iiitdmj/
	The Mechatronics Revolution: Fundamentals and Core Concepts	edX	Online	~100 hours	Monthly subscription	https://www.edx.org/course/mechatronics
Micro & nano fluidics	Introduction to Microfluidics	NPTEL	Online	~50 hours	Free	https://nptel.ac.in/courses/112105187
Microfluidics device design	Digital Microfluidics: Design & Applications	S&T	Offline	5 days	1000	https://www.indiascienceandtechnology.gov.in/conferences-and-seminars/workshops-training-programs/digital-microfluidics-design-applications

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Microwave Photonic Processing	MICROWAVE AND PHOTONICS DEVICES AND MODELLING	IIT - Bhubaneswar	Offline	5 days	1000	https://www.iitbbs.ac.in/MPDM2021/index.php#payment
Modern Civil Construction Methods	Modern Construction Materials	NPTEL-IIT Madras	Online	12 Weeks (Self-paced)	Free	https://nptel.ac.in/courses/105106053
Nano material Fabrication Technology	Fundamentals of micro and nanofabrication	NPTEL-IISc Bangalore	Online	12 Weeks (Self-paced)	Free	https://onlinecourses.nptel.ac.in/noc19_bt29/preview
Nonlinear analysis & CAD Tools	Nonlinear analysis	NPTEL	Online	12 Weeks (Self-paced)	Free	https://archive.nptel.ac.in/courses/108/106/108106162/
Optimization Techniques	Optimization	NPTEL-IIT-Kharagpur	Online	Not available	Free	https://archive.nptel.ac.in/content/syllabus_pdf/111105039.pdf
	Advancements in Signal Processing and Optimization Techniques	IIT-Guwahati	Online	40 hours	Not Available	https://eictacademy.meity.gov.in/courses-iitg/
PCB Layout Design	PCB Design	IIT-Kanpur	Online-Live instructor led	100 hours	Not Available	https://ict.iitk.ac.in/product/pcb-design-eict-stp/
	PCB Design Crash Course: 3D Package & Board Design Approach	Udemy	Online	3.5 hours	650	https://www.udemy.com/course/pcb-design-crash-course-3d-package-board-design-approach/
Piping & pressure vessels	Diploma In Pipe & Pressure Vessels Technology	IISDT	Online	_	3000	https://iisdt.in/product/diploma-in-pipe-pressure-vessels-technology/

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Precision Assembly Processes and Precision Manufacturing	Precision Manufacturing and Process Engineering	CMTI	Offline	8 hours	Paid	https://cmti.res.in/laboratory_services_precision_manufacturing_and_process_engineering/
Process fluid control system design	Smart Materials and Intelligent System Design	IIT Kanpur on NPTEL	Online	4 weeks (self-paced)	free	https://onlinecourses.nptel.ac.in/noc22_me17/preview
Process Plant Design	PLANT DESIGN AND ECONOMICS	NPTEL	Online	12 Weeks	Free	https://archive.nptel.ac.in/content/syllabus_pdf/103105166.pdf
Process simulation software	Simulation and modelling techniques and their Application in Science and Engineering	IIT-Roorkee	Online	40 hours	Paid	https://eictacademy.meity.gov.in/courses-iitr/
	Process Modelling and Simulation	NPTEL	Online	40	Free	https://archive.nptel.ac.in/content/syllabus_pdf/103107096.pdf
Product Development	Developing Innovative Ideas for Product Leaders	Coursera	Online	12 hours	Monthly subscription	https://in.coursera.org/learn/developing-innovative-ideas-for-product-leaders
Python	Three Weeks Online Evening Workshop on Python Programming for Mechanical and Aerospace Applications	IIT-Guwahati	Online	3 weeks	NA	https://www.iitg.ac.in/eictacad/pages_course_details?crs=VUhIdFVDMkhjYy9jUERoLzRrUVY2QT09
	Python for Data Science	IIT-Kanpur	Online	150 Hours	INR 11900	https://ifacet.iitk.ac.in/product/python-for-data-science/

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
MATLAB	SCIENTIFIC COMPUTING USING MATLAB	NPTEL	Online	12 weeks	Free	https://nptel.ac.in/courses/111102137
	MATLAB Programming	IIITDM Jabalpur	Joint Summer Online Course	10 days		https://eictacademy.meity.gov.in/course-iiitdmj/
Quality 4.0 & Implementation	Advancing the Concept of Quality 4.0	Udemy	Online	4 hours	INR 799	https://www.udemy.com/course/advancing-the-concept-of-quality-40/?utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA_Catchall_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_._ag_82569850245_._ad_533220805577_._kw__._de_c_._dm__._pl__._ti_dsa-41250778272_._li_1007785_._pd__._&matchtype=&gclid=Cj0KCQjwla-hBhD7ARIsAM9tQKsuoccMo-C0hj23Ibxl06Cym06AHT9VW_4SXftPsTjHv9SneaYmDX4aAi7bEALw_wcB
Quantum Communication	Introduction to Quantum Communications	IEEE Communications society	189-229 Dollars	10-2:30 EDT on 24/05/2023		https://www.comsoc.org/education-training/training-courses/online-courses/2023-05-introduction-quantum-communications
Quantum Computing	Training Program in Quantum Computing and	C-DAC	Online			https://www.cdac.in/index.aspx?id=edu_et_E_IPC_DACMohali

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
	Information Science					
	Introduction to Quantum Computing: Quantum Algorithms and Qiskit, IBM and IITM	NPTEL	Online		Free	https://archive.nptel.ac.in/content/syllabus_pdf/106106232.pdf
Resource Optimization Methods Techniques	Resource Optimization in Process Industries	IIT-Patna	online Continuous Education Program (CEP)	3 days	Not Available	https://news.careers360.com/iit-patna-organises-3-day-cep-program-resource-optimization-in-process-industries
RF based System Design	RF Design	IIT-Guwahati	Online	40 hours	Paid	https://eictacademy.meity.gov.in/courses-iitg/
	RF System Design	edX	Online	45 hours	Monthly subscription	https://www.edx.org/course/rf-system-design
Red Hat Certified Engineer	Multiple courses based on needs available on Red hat website	Red Hat	-	-	Standard Exam Fee for RHCSA/ RHCE(EX200/EX300): INR 16,500/- plus GST.	https://www.redhat.com/en/services/training/all-courses-exams
Risk Mitigation Techniques	Risk mitigation strategies	Coursera (Part of project planning course)	Online		Monthly subscription	https://www.coursera.org/lecture/project-planning-google/risk-mitigation-strategies-PgC4U

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Robotic Arm Design	Robot Design and Development : Industrial Robots and Robot Arm design	Udemy	Online	5.5 hours	650	https://www.udemy.com/course/robot-design-and-development/
R Programming	R Programming – A Practical Approach	ICT Academy-	Online	6 weeks-self paced	4,237	https://ict.iitk.ac.in/product/r-programming-a-practical-approach/
SPSS	Statistics / Data Analysis in SPSS: Inferential Statistics	Udemy	Online	5 hours	INR 400	https://www.udemy.com/course/inferential-statistics-spss/?gclid=Cj0KCQjwuLShBhC_ARIsAFod4fKP5GSJLZZAGTlDMDtu4g-vBMVdnytntftjodz3I37s2aYo4tlp7I8aAsKDEALw_wcB&matchtype=e&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=udemyads&utm_source=adwords&utm_term=_._ag_80573557913_._ad_533133840129_._kw_spss+course_._de_c_._dm__._pl__._ti_kwd-679319006329_._li_2356_._pd__._
SCADA software	SCADA TRAINING	IPCS				https://ipcsautomation.com/scada-training-institute-india/
Sensor Manufacturing Techniques	Sensor Manufacturing and Process Control	Coursera	Online	55 Hours	Monthly subscription	https://www.coursera.org/learn/sensor-manufacturing-process-control

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Smart material developments	Smart Materials and Intelligent System Design	IIT Kanpur on NPTEL	Online	4 weeks (self-paced)	free	https://onlinecourses.nptel.ac.in/noc22_me17/preview
Software Architecture and Design	Software Architecture Design and Analysis	Carnegie Melon University	Online	4 days	2200 dollars	https://www.sei.cmu.edu/education-outreach/courses/course.cfm?courseCode=P34
Spectroscopy	Fundamentals of Spectroscopy	NPTEL	Online	12 weeks (Self-paced)	Free	https://archive.nptel.ac.in/content/syllabus_pdf/104106122.pdf
Statistical Analysis	Introduction to Statistical Analysis	Coursera	Online	Monthly subscription		https://in.coursera.org/learn/statistical-analysis-hypothesis-testing-sas
System Engineering	SYSTEMS ENGINEERING: THEORY & PRACTICE	NPTEL	Online	8 weeks self-paced	Free	https://archive.nptel.ac.in/content/syllabus_pdf/110104074.pdf
	Essential Model-Based Systems Engineering	AIAA	Online	8 hours	795 dollars	http://aiaa.mycrowdwisdom.com/diweb/catalog/item?id=11085905
Total Quality Management	Total Quality Management	NPTEL	Online	8 weeks self-paced	Free	https://onlinecourses.nptel.ac.in/noc20_mg34/preview
	Total Quality Management	TATA Digi-Shala	Online	4 hours	490	https://capabilitydevelopment.org/Coursedesc/ioc/TOTAL-QUALITY-MANAGEMENT
Unconventional Manufacturing Processes	Advanced Machining Processes	NPTEL	Online	8 weeks self-paced	Free	https://archive.nptel.ac.in/content/syllabus_pdf/112103202.pdf
	Non-Conventional Machining Processes	Udemy	Online	1 hour	Free	https://www.udemy.com/course/non-conventional-machining-processes/

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
Vacuum Technology	Fundamentals of Vacuum Technology	AVS	Offline	4 days	$1,895	https://avs.org/education-outreach/short-courses/short-course-catalog/vacuum-equipment-technology/comprehensive-technology-overviews/test-course/
	Vacuum Technology and Process Application	NPTEL	Online`		Free	https://archive.nptel.ac.in/courses/127/105/127105231/
Vibrational Analysis	Vibrational Analysis	National Power Training Institute		3 days	17400-15400	https://npti.gov.in/vibration-analysis
Web and Android based App development	Certificate in Android-Android app development.	C-DAC	Online	100 hours	Paid	https://www.cdac.in/index.aspx?id=edu_pace_ccrs
	App Development with Android	IIT-Kanpur	Online-Live mode	120 Hours	INR 10,900	https://ifacet.iitk.ac.in/product/app-development-with-android-3/
	Android Basics with Compose	Android	Online	Self-paced		https://developer.android.com/courses/android-basics-compose/course
Alignment Procedures	These domain competencies may be covered in the next ACBP as enough course content and options were not available during our research for the current ACBP.					
Bio-astronautics						
Advanced propellant manufacturing technology						
Advanced Technologies in Safety & Firefighting systems						

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
AI based failure prediction techniques, Quality Inspection	These domain competencies may be covered in the next ACBP as enough course content and options were not available during our research for the current ACBP.					
AI driven Quality Inspection						
Batteries and electrochemical energy systems for Space applications						
Calibration Procedures & Techniques						
Compact Energy Storage Devices and techniques						
EMI analysis						
Environmental Control & Life Support System design for recycling						
Equipment design for Solid Propellant Processing						
FPGA Based System Design						
Geospatial Tools development,						
Geoprocessing and analytics						
High speed rotary system design						
Inflatable Habitat						

Competency	Course Name	Training Provider	Mode	Duration	Fees	Source
structure design	These domain competencies may be covered in the next ACBP as enough course content and options were not available during our research for the current ACBP.					
ISO Standards-What is the specific need?						
Low CTE material design						
Material Handling-What is the specific need?						
Multidisciplinary system design						
Optical Test & Evaluations						
Origami Structure Design						
RHCE: RED HAT certified Engineer						
SDR Based System Design						
Sealing & Leak detection methods						
Self-healing material Development						
Simulation on Combustion Instabilities						
Solid, Liquid and Cryo propellant safety						
Sub Kelvin Temperature Science						
UAV Data processing & Analytics						

Figure 30: Domain competency and training mapping for scientific staff

6.1.3.5. Upcoming courses on Igot

Certain courses are in the process of being developed by CBC and will be available in the next 6 to 12 months. The courses which will be applicable to the needs of the department have been mentioned below along with the levels

#	Competency*	Type	L1	L2	L3
1.	Team Management & Development	B	✓	In-progress	To be developed
2.	Self confidence & Self management	B	✓	✓	To be developed
3.	External Communications	B	✓	✓	To be developed
4.	Influencing & Negotiation	B	✓	To be developed	To be developed
5.	Critical Thinking	B	✓	To be developed	To be developed
6.	E-Office & Office Management	F	✓	To be developed	To be developed
7.	Process improvement	F	✓	✓	To be developed
8.	Project Management	F	✓	In-progress	In progress
9.	Budgeting and Accounting	F	To be developed	To be developed	To be developed
10.	Coaching & Mentoring	F	To be developed	To be developed	To be developed

Table 24: Upcoming courses on iGOT

6.1.3.6. External trainings for other key competencies which may be considered

#	Competency*	Course Title	Course Provider	Mode	Duration	Fee
1	Data Analysis and Management	Big Data Management & Comprehensive Analysis	C-DAC	Online	5 days	-
2	Project Management	Scientific Project Management	IISER-Pune	Residential	1 week	No registration fee
3	Knowledge Management	Knowledge Management	NPTEL	Online	Self Paced	Free
4	Intellectual Property Rights	Online Training Program on Patent filing, Patent search, Patent writing, Trademark, Copyright, Design filing	RGNIIPM	Online	3 days	Free
5	Public Financial Management System	Knowledge of Public Financial Management System	National Institute of Communication Finance	Offline	2 days	Free
6	Networking	Grow and Maintain your Network	Harappa-Thriversity	Online	65 min	Paid
7	Conflict resolving strategies	Workplace Conflict - An Opportunity for Growth	IIM Bangalore	IIM-B Campus	3 days	Paid
8	Presentation Skills	Workshop on effective Presentation Skills	ISTM	Online	2 days	-
9	Innovative Thinking	Innovation and Change Leadership	ASCI	ASCI Hyderabad	3 days	Paid
10	Giving feedback	Give Actionable Feedback	Harappa-Thriversity	Online	1 hr	Paid

6.2. Interventions for Technicians & Technical/Scientific Assistants

After the identification and prioritization of the key competency gaps for the technicians, the trainings, and institutes to address the skill gap requirements were identified. This chapter lists down those trainings.

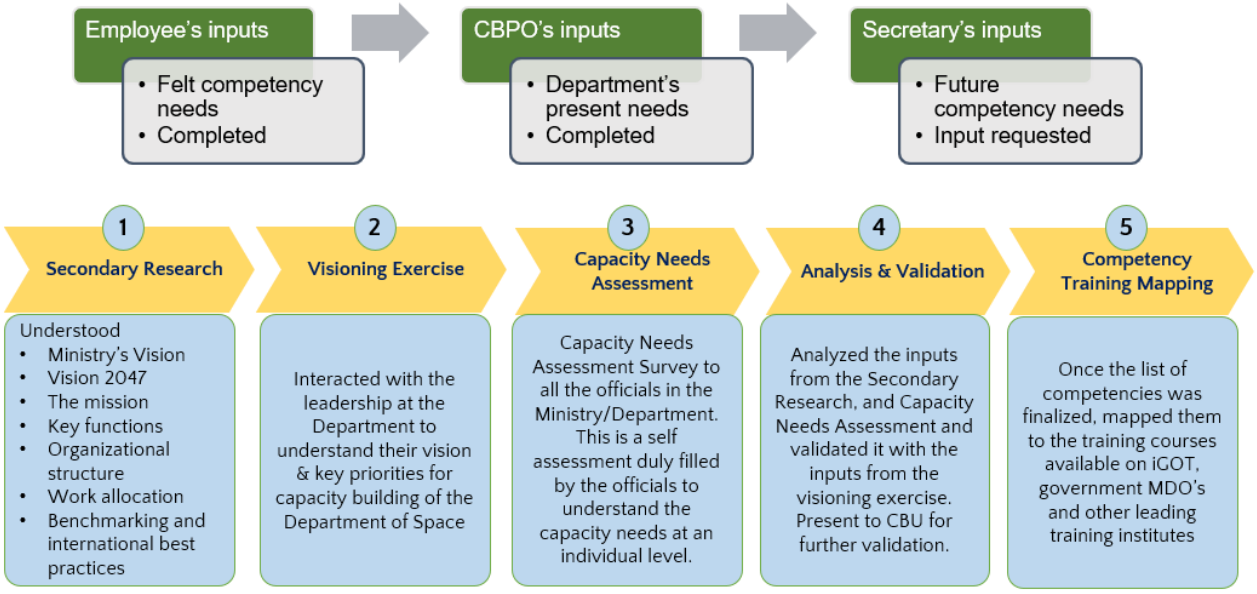


Figure 31: Flowchart for identification of training Interventions[54]

6.2.1. Rationale for mapping of courses and training institutes

For the mapping of the courses and training institutes for the technicians the following rationale was utilized-

[54] Source: PwC Analysis

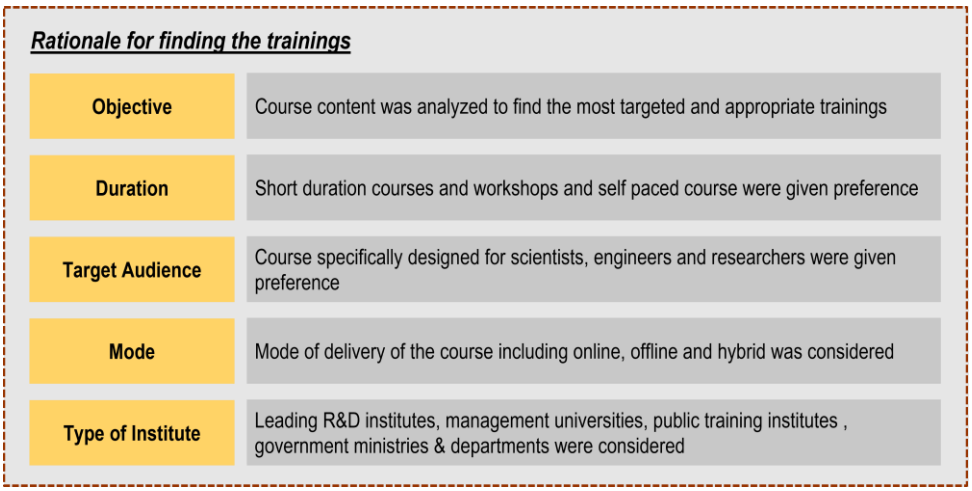


Figure 32: Rationale followed for shortlisting the Courses[55]

6.2.2. Mapping of courses

The next section provides the details on the courses mapped to the competencies identified for the technical staff.

6.2.2.1. Common Project Management module for Technical Staff

A common project management module consisting of prioritized functional and behavioral trainings for the technical staff which may be undertaken in the next 3 months.

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Link
1.	Public Procurement	Training Program On Public Procurement	AJNIFM	In-person	6 days	Link
2.	Understanding of GeM Marketplace	Procurement Process	Government e Market Place (GeM)	Online	2h 49m	iGOT
3.	Vendor Management	Vendor Registration	Government e Market Place (GeM)	Online	20m	iGOT
4.	Project Management	Basics of Project Management	Project Management Institute	Online	45 min	https://www.pmi.org/kickoff/

[55] Source: PwC Analysis

5.	Science Communication	An Introduction to Science Communication	iGOT	Online	2 hours	iGOT
6.	MS Office	Excel advanced	Microsoft	Online	3h 44m	iGOT
7.		Word advanced	Microsoft	Online	2h 49m	iGOT
8.		PowerPoint advanced	Microsoft	Online	2h 19m	iGOT
9.	E-Office	Capacity Building Programme on e-Office for Users (L-1)	E-Office	In person	4 days	https://eoffice.gov.in/Training/courseDetail.php
10.	Overall Personality Development	Personality Development	L&T	Online		https://Intedutech.com/personality-development-program/
11.	Communication Skills	Effective Communication	IIMB	Online	7h 19m	iGOT
12.	Leadership Skills	Leadership Effectiveness & Development	XLRI	In person	Customizable	https://xlri.ac.in/executive-education/corporate-programs/in-company-prog

Figure 33: Common project management module for Technical Staff

6.2.2.2. Exhaustive list of courses mapped to Functional competencies

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Enrollment Fee	Link
1	Working with MS Office	Microsoft Excel for Beginners	Microsoft	Online	6h 56m	Free	iGOT
2	Working with MS Office	Microsoft Word Beginners	Microsoft	Online	2h 56m	Free	iGOT
3	Working with MS Office	Microsoft PowerPoint Beginners	Microsoft	Online	2h 41m	Free	iGOT
4	Working with MS Office	Excel advanced	Microsoft	Online	3h 44m	Free	iGOT
5	Working with MS Office	Word advanced	Microsoft	Online	2h 49m	Free	iGOT
6	Working with MS Office	PowerPoint advanced	Microsoft	Online	2h 19m	Free	iGOT
7	Vendor Management	Vendor Registration	Government e Market Place (GeM)	Online	20m	Free	iGOT
8.	Understanding of GeM Marketplace	Catalogue Management	Government e Market Place (GeM)	Online	42m	Free	iGOT
9.	Understanding of GeM Marketplace	Buyer Dashboard	Government e Market Place (GeM)	Online	15m	Free	iGOT
10.	Understanding of GeM Marketplace	Bid Participation	Government e Market Place (GeM)	Online	21m	Free	iGOT
11.	Understanding of GeM Marketplace	Registration of Buyers	Government e Market	Online	14m	Free	iGOT

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Enrollment Fee	Link
			Place (GeM)				
12.	Understanding of GeM Marketplace	Payment process for Buyers	Government e Market Place (GeM)	Online	33m	Free	iGOT
13.	Understanding of GeM Marketplace	Procurement Process	Government e Market Place (GeM)	Online	2h 49m	Free	iGOT
14.	Understanding of GeM Marketplace	Invoicing and payment Process	Government e Market Place (GeM)	Online	17m	Free	iGOT
15.	Understanding of GeM Marketplace	Introduction to Sellers & Service Provider	Government e Market Place (GeM)	Online	5m	Free	iGOT
16.	Understanding of GeM Marketplace	Introduction to GeM for Buyers	Government e Market Place (GeM)	Online	10m	Free	iGOT
17.	Public Procurement	Training Program On Public Procurement	AJNIFM	In-person	6 days	INR 46,000/- + GST	Link[56]
18.	Contract Management	Contract Management & Arbitration	XLRI	In-person	Customizable	Customizable	https://xlri.ac.in/executive-education/corporate-programs/in-company-prog

[56] Available at https://eprocure.gov.in/cppp/trainingdisp/kbadqkdlcswfjdelrquehwuxcfmijmuixngudufgbuubgubfugbububjxcgfvsbdihbgfGhdfgFHytyhRtODY=

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Enrollment Fee	Link
19.	Project Management	Project and Contract Management	AJNIFM	In-person	6 days	INR 55200/-	Link[57]
20.	Project Management	Workshop on Scientific Project Management	IISER-Pune	Online	5 days	Paid	https://www.iiserpune.ac.in/events/3422/workshop-on-scientific-project-management
21.	Project Management	IT Project Management	ISB	Online	12 Weeks (3-4 hours daily)	INR 1,10,000 + GST	Link[58]
22.	Project Management	Project Management Basics	Project Management Institute	Online	23 Hours	INR 21,624	https://www.pmi.org/shop/india/p-/elearning/project-management-basics---an-official-pmi-online-course/16125
23.	Project Management	Basics of Project Management	Project Management Institute	Online	45 min	Free	https://www.pmi.org/kickoff/

[57] Available at https://eprocure.gov.in/cppp/trainingdisp/kbadqkdlcswfjdelrquehwuxcfmijmuixngudufgbuubgubfugbububjxcgfvsbdihbgfGhdfgFHytyhRtODY=

[58] Available at https://online-er.isb.edu/certificate-program-in-it-project-management/index.php?utm_source=Google&utm_medium=Search&utm_campaign=IS_IN_ISB_ITPM_Async_GG_SE_Jan_23_Core_Generic_Phrase_Tier1&utm_content=Project_Management&utm_term=Project%20management%20education&gclid=CjwKCAiAzp6eBhByEiwA_gGq5DPErrlFiIkHL5z8V1o8grY6AD7kaMQBsC436kIGFdKOk9P4GYwloxoCnDUQAvD_BwE

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Enrollment Fee	Link
24.	Innovation Management	Managing Innovation	IIMB on edX	Online	20-30 hours	Free	https://www.edx.org/course/managing-innovation
25.	Innovation Management	Innovation, Business Models and Entrepreneurship	NPTEL	Online	8 weeks (Self-paced)	Free	https://archive.nptel.ac.in/content/syllabus_pdf/110107094.pdf
26.	Science Communication	An Introduction to Science Communication	iGOT	Online	2 hours	Free	iGOT
27.	Scientific Writing Proficiency	Discovering Science: Science Writing	University of LEEDS	Online	10 hours	INR 1,100	https://www.futurelearn.com/courses/discovering-science-science-writing?utm_campaign=Courses+feed&utm_medium=courses-feed&utm_source=courses-feed
28.	Scientific Writing Proficiency	Workshop on Scientific Writing	Welcome Trust- DBT India Alliance	In person	1 day	-	https://ftp.tifrh.res.in/~sciencemedia/index.php/2020/10/18/scicomm101/
29.	Understanding of functioning of E-office	Capacity Building Programme on	E-Office	In person	4 days	-	https://eoffice.gov.in/Training/cou

S. No	Competency	Course Title	Course Provider	Mode of training	Duration	Enrollment Fee	Link
		e-Office for Users (L-1)					rseDetail.php
30.	General	Emerging Technology	iGOT	Online	2.5	Free	iGOT

Table 25: Functional Competencies mapped from analysis[59]

6.2.2.3. Exhaustive list of courses mapped to Behavioral competencies

Sl. No.	Competency	Course Title	Course Provider	Mode	Duration	Enrollment Fee	Link
1.	Overall	Personality Development	L&T	Online		(Around 8k-10k per person)	https://lntedutech.com/personality-development-program/
2.	Communication Skills	Effective Communication	IIMB	Online	7h 19m	Free	iGOT
3.	Leading others	Building Science Leaders Program	CTIER & Ahmedabad University	Hybrid	6 days	-	https://pib.gov.in/PressReleasePage.aspx?PRID=1863365
4.	Leadership Skills	Leadership Effectiveness & Development	XLRI	In person	Customizable		https://xlri.ac.in/executive-education/corporate-programs/in-company-prog

[59] Source: CBPO, ISRO, PwC Analysis

Sl. No.	Competency	Course Title	Course Provider	Mode	Duration	Enrollment Fee	Link
5.	Leadership Skills	Self Leadership	Art of Living	Online	1.27 hours	Free	iGOT
6.	Team Management/ Leadership	Training Course - Leadership and Team effectiveness	NPTEL	Online	12 weeks	Free	https://archive.nptel.ac.in/content/syllabus_pdf/110107159.pdf
7.		POSH	ISTM	Online	1.86	Free	iGOT

Table 26: Behavioral competencies mapped from analysis[60]

[60] Source: CBPO, ISRO, PwC Analysis

6.2.2.4. Exhaustive list of courses mapped to Domain competencies

S. No.	Course Title	Course Provider	Mode	Duration	Fee	Course Objectives
1.	Electricity & Safety Measures	IGNOU	Online	12 weeks	Paid	• Earthing • Important Electricity Rules Related to Safety • Electrical System Protection • Electrical Safety Accident Prevention & Protection • Electrical installation protection and safety precautions • Disaster Management • First Aid
2.	Introduction to CAD, CAM, and Practical CNC Machining	Coursera	Online	20 hours	Monthly Subscription based	• CAD design process as applied to prismatic parts. • Demonstrate knowledge and skills in basic Fusion 360 CAM. • Recall foundational knowledge of practical CNC machining
3.	AutoCAD 2D & 3D Training Programme	CMIFR	Online	12 days	Paid	• Fundamentals of AutoCAD
4.	Introduction to CNC Programming	Udemy	Online	2 hours	INR 550	• Fundamentals of CNC Programming
5.	Linux Operating System	IIT-B on Swayam Portal	Online	Self-paced	Free	• Use of the wide variety of Linux commands to handle files, directories, processes, etc. created using Ubuntu version 10.04 and above
6.	LabVIEW	National Instruments	Online	7/5 hours	INR 38,900	• LabVIEW environment and interactive analysis, dataflow programming, and common development techniques in a hands-on format. • In this course, you will learn how to develop data acquisition, instrument control, data-logging, and measurement analysis applications.

S. No.	Course Title	Course Provider	Mode	Duration	Fee	Course Objectives
						• At the end of the course, you will be able to create applications using the state machine design pattern to acquire, analyze, process, visualize, and store real-world data
7.	Advanced Hardware and PCB Design Masterclass	Udemy	Online	23 hours	INR 550	• Fundamentals of PCB Design

Figure 34: List of courses mapped to Domain competencies

Further, some of the other training interventions can be classified as quick wins and long-term interventions that the institutes can apply in the short and long term respectively. These would include-

6.3. Non-Training Interventions for ISRO

a. Working in silos to be reduced gradually, thereby allowing more collaboration between departments and centers. This may be done by cross utilizing of workforce across centers and projects.

b. Access to software, coding languages and platforms for faster turnaround of projects and tasks

c. Project Management platforms to be adopted for agile management of projects, at least on pilot.

d. Feedback mechanisms and frameworks to be explored for two-way channel - bottom to top and top to bottom communication flow

e. Programs, field visits, immersion programs or exposure to other centers, inter-ministerial efforts using space technology and cross learning opportunities with scientists from other domains, enabling peer-to-peer learning and networking

f. Knowledge transfer and management using digital repository platforms to be implemented

g. For higher and improved scientific publications, access to journals and similar avenues to be democratized. Strengthening of patent filing process at ISRO centers to reduce turn-around time.

h. Conceptualization of Innovation framework to engage scientists from different departments towards a common national challenge like GIS to map agricultural harvest, forestry, water level monitoring, telemedicine for robust healthcare delivery, Drone, or robotics for automation in agriculture etc.

i. Mentoring of scientists should be taken up to ensure continuous development of practices, processes, and personnel. Also, necessitating effortless transition into new projects or even knowledge transfer.

j. Capacity Building should be made a reiterative process at least on an annual basis, by identifying capacity building needs of workforce in tandem with national priorities and industry needs

Further the following interventions may be considered-

a. Implementing Learning Hour every week

a. Starting the iGOT courses to which the competencies have been mapped

b. Inter-institute visits including visit of ground systems entity, MCF to Satellite Assembly & Integration Facility

k. Partner with training institutes for taking the responsibility of capacity building at the department

l. Listing out mandatory iGOT courses for the ministry officials and linking the progress to APAR where the minimum training requirement may be defined at 50 hours in a calendar year. ISRO may define details of the penalties and other measures in case the minimum training requirement is not met by the scientific and non-scientific staff.

m. ISRO may also consider interacting with global leaders in Space technology and organize 45 min to one hour talks (preferably in virtual mode to ensure that maximum staff can attend) as part of the Learning Hour. The same may also be communicated to other S&T departments, as and when organized, to allow participation from maximum scientific and technician staff.

6.4. Organizational and Individual Interventions mapped across short and long term

To gauge capacity needs at the organizational level, each wing/division/section of the MDO will need to be assessed based on aspects, including but not limited to:

- **Technology and Data: -** This dimension deals with the technological tools the MDO has used to enhance its performance. Among these are PQSoft for managing parliamentary questions for the MDO and software that offers a quicker turnaround time on repeated work. Other examples include digital solutions that improve productivity or enable quicker pain-point resolution.
- **Systems and Processes: -** This dimension covers all of the MDO's developed methods and procedures for carrying out daily operations. Examples include learning management systems, standard operating procedures, and monitoring mechanisms for programs.
- **Resources and Assets: -** This covers the MDO's assets and resources, including the hard and soft infrastructure needed for day-to-day operations. For instance, the actual location, financial resources, etc.
- **Partnerships and Relationships: -** All external relationships, such as those with other ministries or departments, international organizations, and citizen groups, are included in this dimension.
- **Personnel Management: -** This covers all activities related to managing the MDO's human resources, including performance reviews, learning and development, performance management, succession planning, etc.

Capacity Required	Dimension	Intervention	Logistics to bridge the gap			
			Prerequisites (if any)	HR requirements	Estimated Cost	Estimated Timeline
This is part of lifelong learning and to gain better understanding of concepts outside the area of expertise	Personnel Management	**Learning Hour** • One hour a week is declared as learning hour. • A topic can be chosen the participation is voluntary, officials who require that knowledge will join it.	Conference Hall & Video conferencing	Internal (a senior officer in the area) or external expert on the topic chosen	TBD	TBD
To gain a better understanding of the industry	Partnerships & Relationships Personnel Management	**Immersion Program:** Exposure to other centers, inter-ministerial efforts using space technology and cross learning opportunities with scientists from other domains, enabling peer-to-peer learning and networking	Immersion Program draft to be confirmed by the relevant stakeholder	Nodal officer to look after the immersion program and act as a Single Point of Contact (SPOC) for the industry	TBD	TBD

Capacity Required	Dimension	Intervention	Logistics to bridge the gap			
			Prerequisites (if any)	HR requirements	Estimated Cost	Estimated Timeline
To clear queries/doubts on some of the operations / technology/ systems/ processes of the Department	Personnel Management	**Virtual Kiosks:** • Will have a basic introduction to the process and how to use them • Then a doubt clearing session, where most of the doubts to be addressed by the experts in the process	Conference Room or Virtual video conferencing	Experts on the process/ technology/ systems within the Department	TBD	TBD
Improve and expand access to research data	Systems & processes	**Digital repository platforms for knowledge transfer and management**	-	A team of IT officers to maintain the portal and regularly update it	TBD	TBD
Increase the effectiveness of Project Management	Technology and Data	**Project Management Platform for agile management**	• Computers • Emails	Technical officer, to act as nodal officer for queries on the tool	TBD	TBD
To clear very small quick questions related to the departmen	Technology & data	**'Space assist' chatbot to answer quick questions:** • One place for all basic	• Department of Space and space technol	A dedicated team of 5-7 people to train the bot on the content	TBD	TBD

Capacity Required	Dimension	Intervention	Logistics to bridge the gap			
			Prerequisites (if any)	HR requirements	Estimated Cost	Estimated Timeline
t, pharmaceuticals, and medical devices		queries and doubts related to Department of Space	ogy related content	and content related to the Department's functions or operations		

In addition to the above listed interventions, some of the other individual level interventions were mapped to the time that it would take to implement them and divided into Quick wins and long-term interventions. These have been presented in the below figure

The above listed interventions were categorized to organizational and individual levels and mapped to the time that it would take to implement them.

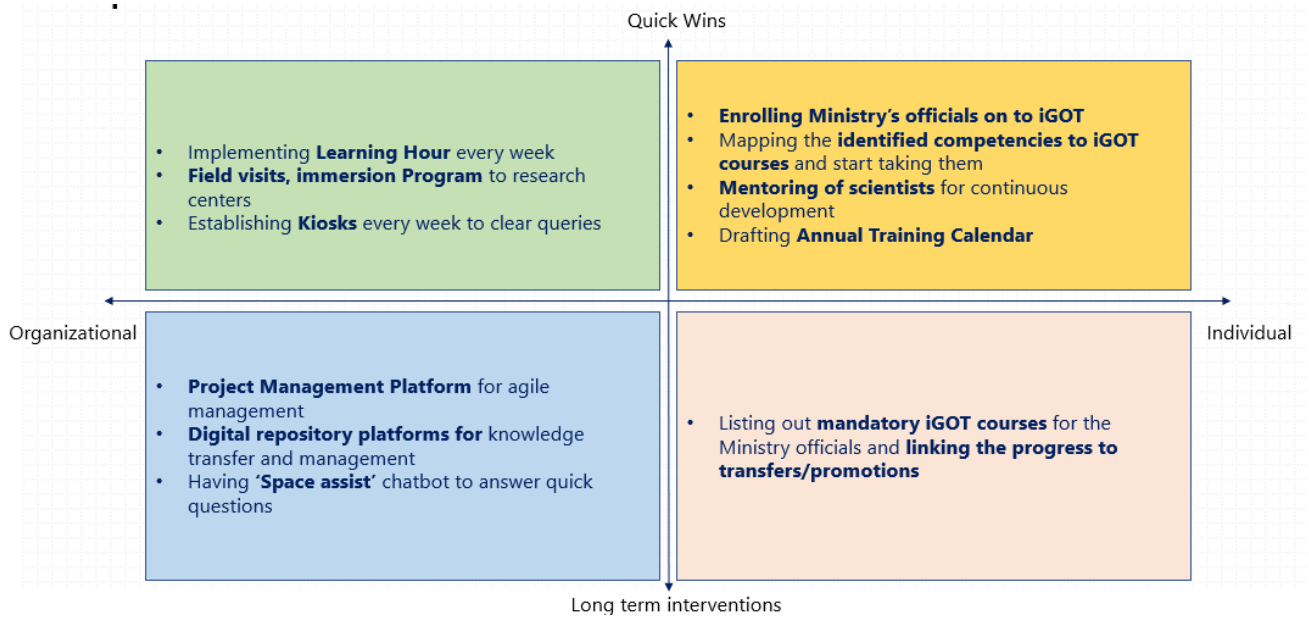


Figure 35: Interventions mapped to Quick Wins and Long-term

Quick wins are the interventions that can be implemented immediately. These include the following-

- Enrolling Ministry's officials on to iGOT
- Mapping the identified competencies to iGOT courses and start taking them
- Implementing **Learning Hour** every week

- Field visits, **immersion Program** to research centers
- Establishing **Kiosks** every week to clear queries
- Mentoring of scientists for continuous development
- Training on POSH and Emerging Technologies

6.5. Interventions mapped to time required for implementation

The interventions have been mapped to the time required for their implementation. These have been divided into short term and long term. The mapping has been mentioned in the below figure-

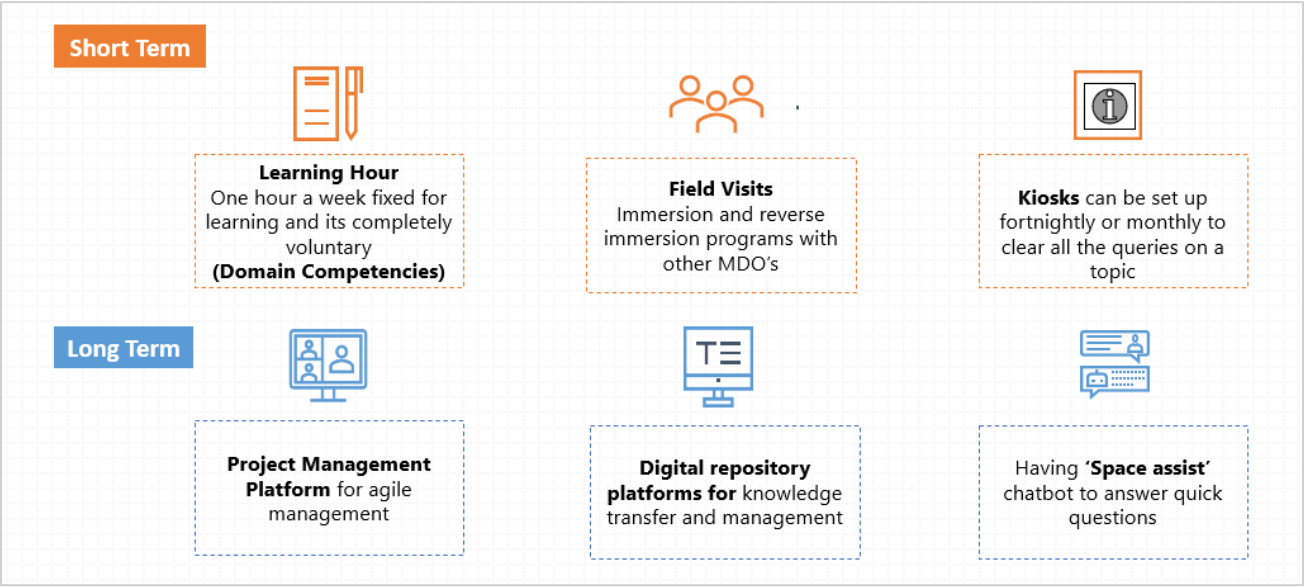


Figure 36: Interventions mapped to short term and long term

6.6. Progress across Quick Wins

A total 224 staff of ISRO have registered on iGOT, 132 have completed different trainings. The details have been mentioned below. Virtual Kiosks,

S.No.	Type of Intervention	Competency	No. of Persons
1.	Virtual Kiosk	General Financial Rules, 2017 & Public Financial Management System	2 sessions for GFR and PFMS have been conducted
2.	iGOT Training	Prevention of Sexual Harassment of Women at Workplace	15
3.	iGOT Training	Microsoft Word Beginners	11
4.	iGOT Training	Microsoft Excel for Beginners	11
5.	iGOT Training	Effective Communication	7

Table 27: Progress on Quick Wins

7. Global best practices in capacity building for space sector

The capacity building initiatives in any domain have some overarching guiding principles which apply across government and non-government sectors and the DoS may consider incorporating these principles in the development of future capacity building plans[61]. These principles, if applied, would contribute to more effective and sustainable capacities to support the growth of the space sector in India as well as for DoS and ISRO.

7.1. Development of a strategic framework for long term capacity building

The strategic framework must incorporate elements from the capacity definition of the ability of people, organisation, and societies as a whole to achieve the objectives of the Indian Space Program, its goals and action targets. Capacity development as part of the strategic framework is to be understood as the process whereby people, organizations and society as a whole unleash, strengthen, create, adapt, and maintain capacity over time to achieve positive results in the space activities in the upstream, midstream, and downstream domains. The strategic framework must include the undermentioned tenets, but is not limited to these alone, and may include any other aspects that the Department of Space considers necessary.

7.1.1. Overall vision and theory of change

The overall vision and theory of change must align with the national agenda, the need for change, and the approach and methodology to identify and address the changes that need to be made in the way capacity building is currently envisaged. The vision must be clearly defined for the short, medium and the long term in a manner to support ongoing development and strengthening of capacities necessary for the achievement of the goals set by the Department of Space.

7.1.2. Expected capacity results

7.1.2.1. Long-term high-level outcomes

a. Successful implementation of capacity building initiatives as per action plan
b. Building a culture of healthy competition that fosters leaning and development for individuals
c. Improved and strengthened access to technology for effective participation in capacity building initiatives
d. Long term strategic alignment with the national agenda on capacity building

[61] Source: https://www.cbd.int/doc/c/f071/ba75/4aeaaa842acdaf622d1b6a18/cop-15-l-28-en.pdf

7.1.2.2. Medium term outcomes

a. Development/update of the national capacity building initiatives
b. Strategic partnerships and institutional arrangements to support achievement of national agenda on capacity building
c. Development of enabling frameworks and diligent implementation
d. High quality programs and projects with embedded monitoring and achievable objectives
e. Effective monitoring and evaluation processes end-to-end
f. Reinforcing mechanisms, incentive structures and investments to ensure utilization and retention of capacity of all types at all levels

7.1.3. Guiding principles

The following guiding principles will be applied to the capacity-building and development, which would contribute to creation of more effective and sustainable capacities in the department-

a. To ensure effective interventions, holistic analysis of existing capacities and needs is required
b. Country ownership should be central to the capacity-building and development process
c. Strategic and integrated system-wide approaches to capacity-building and development should be promoted based on the national priorities and citizen centric goals
d. Interventions should be designed and implemented based on the global and national best practices
e. Scientific, technical, and administrative staff perspectives should be fully integrated into capacity-building and development efforts
f. Monitoring & evaluation frameworks should be incorporated into capacity-building and development strategies, plans and programs throughout the process

7.1.4. Key Strategies

The strategies mentioned below may be applied to enhance capacity-building and development initiatives and further ensure alignment and synergy with the national priorities and citizen centric goals.

a. Institutionalize capacity-building and development
b. Integrate long-term capacity-building and development into national action plans
c. Increase focus on life-long learning
d. Align the departments capacity-building and development with broader cross-sectoral plans and programs
e. Undertake measures to fully utilize and retain existing capacity
f. Develop thematic and regional and/or subregional capacity-building and development action plans and programs

g. Promote partnerships and networks for implementation

h. Enhance synergies between capacity-building and development efforts of relevant processes

i. Engage the private sector

j. Strengthen the monitoring and evaluation of capacity-building and development interventions

7.1.5. Mechanism for Implementation

There is a need for mechanisms that could provide strategic leadership and foster coordinated capacity-building at the national level. These mechanisms include

1) Governance and coordination mechanisms: The role of this mechanism involves-

   a. Enhancing synergy, by facilitating inter-agency coordination and cooperation among relevant organizations, initiatives, and funding agencies

   b. Providing guidance and advice to government and non-government actors

   c. Promoting strategic and coherent approaches to capacity-building and development

   d. Fostering partnerships and multi-stakeholder initiatives

   e. Identifying opportunities to mobilize additional resources for capacity-building and development efforts

   f. Proposing innovative ideas to improve and advance the implementation of the strategic framework

   g. Resource mobilization for capacity-building and development

   h. Mutual supportiveness between various implementation strategies and processes

   i. Regional and global support networks

   j. Enhanced review mechanisms

   k. Reporting and review of the framework

8. Capacity Building Calendar for Scientific Staff

8.1. Designation Wise Capacity Building Calendar

For making the capacity building calendar for the scientific staff, the competencies that are crucial were selected. Also, the course which are readily available on various platforms like iGOT have been shortlisted. The proposed designation wise capacity building calendar is mentioned below-

Table 28:: Proposed Capacity Building Calendar for Scientist/ Engineer-SG

#	Course Title	Organization	Course Provider	Duration	When
1.	Leadership Module (COMMIT)	VSSC, SDSC, ISTRAC, MCF, SAC, IISU, NRSC	iGOT (DoPT)	1.5 h	Q1-Q2
2.	Team management, sensitiveness to team (BSNL Mission Karamyogi)	All organizations	iGOT (BSNL)	.33 h	Q1-Q2
3.	Knowledge sharing & mentorship	All organizations	iGOT (BSNL)	.86 h	Q1-Q2
			Total Time in Q1	2.7 h	
4.	Problem Solving and Decision-Making module of COMMIT	All organizations	iGOT (DoPT)	1.67 h	Q2
5.	.An Introduction To Science Communication	VSSC, URSC, SDSC, ISTRAC, MCF, SAC, IISU, NRSC	iGOT	2 h	Q2
6.	POSH	All organizations	iGOT (ISTM)	1.86 h	Q2
7.	Emerging Technology	All organizations	iGOT	2.5 h	Q2
			Total Time in Q2	6.53 h	
8.	Effective Communication	SDSC, ISTRAC, MCF, SAC, IISU	iGOT (IIMB)	7.33 h	Q3
9.	Vendor Management	URSC, ISTRAC, IISU, MCF, NRSC	iGOT (GeM)	.33 h	Q3
10.	Basics of Project Management*	VSSC, URSC, HSFC, ISTRAC, MCF, SAC, IISU	PMI*	.75 h	Q3
			Total time in Q3	8.41 h	
			Total time Q1-Q3	**17.64 h**	

Table 29: Proposed Capacity Building Calendar for Scientist/ Engineer-SF

Sl. No.	Course Title	Proposed Participants	Course Provider	Duration	When
1.	Leadership Module (COMMIT)	VSSC, SDSC, ISTRAC, MCF, SAC, IISU, NRSC	iGOT (DoPT)	1.5 h	Q1-Q2
2.	Team management, sensitiveness to team	All organizations	iGOT (BSNL)	.33 h	Q1-Q2
3.	Knowledge sharing & mentorship	All organizations	iGOT (BSNL)	.86 h	Q1-Q2
			Total Time in Q1	2.7 h	
4.	Problem Solving and Decision-Making module of COMMIT	• All organizations	iGOT (DoPT)	1.67 h	Q2
5.	An Introduction To Science Communication	VSSC, URSC, SDSC, ISTRAC, MCF, SAC, IISU	iGOT	2 h	Q2
6.	POSH	• All organizations	ISTM (IGOT)	1.86 h	Q2
7.	Emerging Technology	• All organizations	iGOT	2.5 h	Q2
			Total time in Q2	6.53 h	
8.	Effective Communication	VSSC, URSC, SDSC, HSFC, ISTRAC, MCF, IISU, NRSC	iGOT (IIMB)	7.33 h	Q3
9.	Vendor Management	VSSC, URSC, SDSC, ISTRAC, MCF, IISU	iGOT (GeM)	.33 h	Q3
10.	Basics of Project Management*	VSSC, SAC, URSC, SDSC, HSFC, HSFC, ISTRAC, MCF, IISU	PMI	.75 h	Q3
			Total time in Q3	8.41 h	
			Total time Q1-Q3	**17.64 h**	

Table 30: Proposed Capacity Building Calendar for Scientist/ Engineer-SE

Sl. No.	Course Title	Proposed Participants	Course Provider	Duration	When
1.	Leadership Module (COMMIT)	URSC, ISTRAC, MCF, IISU	iGOT (DoPT)	1.5 h	Q1-Q2
2.	Team management, sensitiveness to team	All organizations	iGOT (BSNL)	.33 h	Q1-Q2
3.	Knowledge sharing & mentorship	All organizations	iGOT (BSNL)	.86 h	Q1-Q2
			Total Time in Q1	2.7 h	
4.	Problem Solving and Decision-Making module of COMMIT	• All organizations	iGOT (DoPT)	1.67 h	Q2
5.	An Introduction To Science Communication	VSSC, URSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT	2 h	Q2
6.	POSH	• All organizations	ISTM (IGOT)	1.86 h	Q2
7.	Emerging Technology	• All organizations	iGOT	2.5 h	Q2
			Total time in Q2	6.53 h	
8.	Effective Communication	SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT (IIMB)	7.33 h	Q3
9.	Vendor Management	SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT (GeM)	.33 h	Q3
10.	Basics of Project Management*	VSSC, URSC, SDSC, HSFC, ISTRAC, MCF, SAC, IISU	PMI	.75 h	Q3
			Total time in Q3	8.41 h	
			Total time Q1-Q3	**17.64 h**	

Table 31: Proposed Capacity Building Calendar for Scientist/ Engineer-SD

#	Course Title	Proposed Participants	Course Provider	Duration	When
1.	Leadership Module (COMMIT)	URSC, ISTRAC, MCF, IISU	iGOT (DoPT)	1.5 h	Q1-Q2
2.	Team-Working (COMMIT)	All organizations	iGOT (DoPT)	1.33 h	Q1-Q2
3.	Understanding of GeM (Collection of courses)	URSC, SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT (GeM)	5.76 h	Q1-Q2
			Total in Q1	8.59 h	
4.	MS Office (Excel advanced; Word advanced; PowerPoint advanced)	All organizations	iGOT	3.75 h; 2.83 h; 2.33 h	Q2
5.	An Introduction To Science Communication	SDSC, URSC, ISTRAC, MCF, SAC, IISU	iGOT	2 h	Q2
6.	POSH	All organizations	ISTM (iGOT)	1.86 h	Q2
			Total time in Q2	12.77 h	
7.	Problem Solving and Decision-Making module of COMMIT	All organizations	iGOT (DoPT)	1.67 h	Q3
8.	Effective Communication	URSC, ISTRAC, MCF, IISU	iGOT (IIMB)	7.33 h	Q3
9.	Understanding Motivation	All organizations	iGOT (LBSNAA)	1.6 h	Q3
10.	Emerging Technology	All organizations	iGOT	2.5 h	Q3
11.	Basics of Project Management	URSC, HSFC, MCF, SAC, IISU	PMI*	.75 h	Q3
			Total time in Q3	13.83 h	
			Total time	**35.19**	

Table 32: Proposed Capacity Building Calendar for Scientist/ Engineer-SC

#	Course Title	Proposed Participants	Course Provider	Duration	When
1.	Leadership Module (COMMIT)	SDSC, HSFC, ISTRAC, MCF, IISU	iGOT (DoPT)	1.5 h	Q1-Q2
2.	Team-Working (COMMIT)	All organizations	iGOT (DoPT)	1.33 h	Q1-Q2
3.	Understanding of GeM (Collection of courses)	SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT (GeM)	5.76 h	Q1-Q2
			Total in Q1	8.59 h	
4.	MS Office (Excel advanced; Word advanced; PowerPoint advanced)	All organizations	iGOT	3.75 h; 2.83 h; 2.33 h	Q2
5.	An Introduction To Science Communication	VSSC, SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT	2 h	Q2
6.	POSH	All organizations	ISTM (iGOT)	1.86 h	Q2
			Total time in Q2	12.77 h	
7.	Problem Solving and Decision-Making module of COMMIT	All organizations	iGOT (DoPT)	1.67 h	Q3
8.	Effective Communication	SDSC, HSFC, ISTRAC, MCF, SAC, IISU	iGOT (IIMB)	7.33 h	Q3
9.	Understanding Motivation	All organizations	iGOT (LBSNAA)	1.6 h	Q3
10.	Emerging Technology	All organizations	iGOT	2.5 h	Q3
11.	Basics of Project Management	VSSC, SDSC, HSFC, ISTRAC, MCF, SAC, IISU	PMI*	.75 h	Q3
			Total time in Q3	13.83 h	
			Total time	**35.19**	

*If no training level is mentioned for a particular grade of scientist, we have assumed that the competency is not required for them

8.2. Common Implementation Plan

Based on the designation wise training needs a common implementation plan for ISRO has been prepared. These common training may be started immediately for all Scientist and engineer staff.

Table 33: Common Implementation Plan for Scientist/ Engineers for next 6 months

#	Competency*	Course Title	Course Provider	Level	Duration	Fee
1.	Leadership	Self-Leadership	iGOT	L-1	1.5 h	Free
2.	Science Communication	An Introduction to Science Communication	iGOT	L-1	2 h	Free
3.	Gender Sensitization	POSH	ISTM (iGOT)	L-1	1.86 h	Free
4.	Problem Solving and Decision Making	Data driven decision making	iGOT (DoPT)	L-1	2.5 h	Free
5.	Communication Skills	Effective Communication	iGOT (IIMB)	L-2	7.33 h	Free
6.	Emerging Technology	Emerging Technology	iGOT	L-1	2.5 h	Free
7.	Project Management	Project Management	iGOT (NAIR)	L-1	.75 h	Free
8.	International leadership	Policy Making	iGOT (Under development)	L-1	-	Free

8.3. Recommended Trainings for the Admin staff

#	Competency*	Course Title	Course Provider	Mode	Duration	Fee
1	Multiple	DAKSTHA	iGOT (ISTM)	Online	16h 54m	Free
2	Multiple	DAKSTHA	iGOT (ISTM)	In-person	5 days	Free
3	Gender Sensitization	Prevention of Sexual Harassment of Women at Workplace (POSH)	iGOT (ISTM)	Online	1.86 h	Free
4	Emerging Technology	Introduction to Emerging Technologies	iGOT (WITP)	Online	2.5 h	Free
5	Science Communication	An Introduction to Science Communication	iGOT	Online	2 h	Free
6	MS Office	Excel advanced	iGOT (Microsoft)	Online	3.75 h	Free
7	MS Office	Word advanced	iGOT (Microsoft)	Online	2.83 h	Free
8	MS Office	PowerPoint advanced	iGOT (Microsoft)	Online	2.33 h	Free
9	Communication Skills	Effective Communication	iGOT (IIMB)	Online	7.33 h	Free
10	Know your Department	-	ISRO	Online/Offline	TBD	Free

9. M&E Framework

The proposed M&E Framework has been mentioned below. This may be used for monitoring and evaluating the progress in the training and non-training interventions along with the outputs produced by them.

Objectives/Activities		Indicator	Definition	Means of verification	Unit	Targets		Reporting Frequency	Partners involved
						Y 1	Y 2		
Objective									
1.	Capacity Building of staff	Courses completed by 20% of staff	• Online courses completed on iGOT etc • Offline courses physically attended	• Course completion certificates • Data available on iGOT platform	%	Targets		Quarterly	CBC, MDO, iGOT team
						Completion of courses by 20% of staff	Completion of courses by 40% of staff		
Outcome 1									
2.	Improvement in Efficiency of scientists	Productivity Analysis	• Methodology used by the Department for productivity analysis of its staff	• Monitoring Report of various labs, institutes under the Department	-	Targets		Annually	CBC, Department of Space, ISRO and other institutes
						Increase in productivity by 5%*	Increase in productivity by 10%		
Outcome 2									
3.	Improvement in Efficiency of Technical staff	Productivity Analysis	• Methodology used by the Department for productivity analysis of its staff	• Monitoring Report of various labs, institutes under the Department	-	Targets		Annually	CBC, Department of Space, ISRO and other institutes
						Increase in productivity by 5%*	Increase in productivity by 10%		

	Objectives/Activities	Indicator	Definition	Means of verification	Unit	Targets		Reporting Frequency	Partners involved
						Y 1	Y 2		
Output									
4.	Individual Capacity of the department is improved	% of People who have taken up recommended courses	• Online courses completed on iGOT etc • Offline courses physically attended	• Monitoring and evaluation report • ACBP of the department	%	Targets Completion of courses by 20% of staff	Completion of courses by 40% of staff	Annually	CBC, MDO, iGOT team
Activity 1									
5.	Conduction of courses on iGOT	Percentage of staff who have completed the recommended courses on iGOT	• Courses based on the designation wise competency needs of the department would be recommended	• Course completion certificates • Data available on iGOT platform	%	Targets Completion of courses by 20% of staff	Completion of courses by 40% of staff	Quaterly	CBC, Department of Space, ISRO and other institutes
Activity 2									
6.	Physically attending the Offline/ Hybrd courses	Percentage of staff who have attended the recommended courses physically	• Courses based on the designation wise competency needs of the department would be recommended	• Course completion certificates	%	Targets Completion of courses by 20% of staff	Completion of courses by 40% of staff	Quaterly	CBC, Department of Space, ISRO and other institutes

Appendix A. - Appendices

A.1. Geographical locations of the Institutes and Labs of DoS

S.no	Center Name	Location
1	U R Rao Satellite Centre (URSC)	Bengaluru
2	DOS/ISRO HQ	Bengaluru
3	ISRO Telemetry, Tracking and Command Network	Bengaluru
4	ANTRIX	Bengaluru
5	New Space India Limited	Bengaluru
6	Human Space Flight Centre	Bengaluru
7	Master Control Facility	Hassan & Bhopal
8	Vikram Sarabhai Space Centre	Thiruvananthapuram
9	Indian Institute of Space Science and Technology	Trivandrum
10	Liquid Propulsion Systems Centre	Trivandrum & Bengaluru
11	Satish Dhawan Space Centre	Sriharikota
12	National Atmospheric Research Laboratory	Tirupati
13	Physical Research Laboratory	Ahmedabad
14	Space Applications Centre	Ahmedabad
15	National Remote Sensing Centre	Hyderabad
16	Advanced Data Processing Research Institute	Secunderabad
17	ISRO Propulsion Complex	Mahendragiri
18	Indian institute of remote sensing	Dehradun
19	North-Eastern Space Applications Centre	Shillong

Figure 37: Geographical Mapping of the labs and institutes of DoS

A.2. Appendix – Detailed mapping of competencies for Scientific staff

Behavioural Competencies – Trivandrum	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Assertiveness	Intermediate		Advanced		
Attention To Detail			Advanced	Advanced	Advanced
Communication Skills	Intermediate		Intermediate		Intermediate
Conceptual Thinking	Intermediate		Intermediate	Advanced	
Conflict resolving strategies	Basic			Advanced	Advanced
Consultation & Consensus Building			Intermediate	Advanced	Intermediate
Decision Making	Intermediate		Advanced	Advanced	Advanced
Delegation	Basic		Basic	Advanced	Basic

Behavioural Competencies – Trivandrum	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Desire For Knowledge				Advanced	Advanced
Developing Others			Intermediate	Advanced	Basic
Ethics				Advanced	
Giving feedback				Advanced	Basic
Initiative & Drive					Intermediate
Innovative Thinking	Basic		Advanced		Advanced
Integrity				Advanced	Intermediate
Leading Others			Intermediate	Advanced	Advanced
Motivating others					Intermediate
Negotiation			Basic		Advanced
Networking skills	Intermediate		Basic	Advanced	Intermediate
Organizational Awareness			Intermediate		Intermediate
People First			Intermediate		
Planning & Coordination			Advanced	Intermediate	Intermediate
Problem Solving	Basic		Advanced	Advanced	Intermediate
Recruitment					Intermediate
Result Orientation	Intermediate		Intermediate	Advanced	
Running Effective Meetings			Advanced	Advanced	Advanced
Seeking Information	Basic		Basic		
Self-awareness and control				Advanced	
Self Confidence			Intermediate	Advanced	Intermediate
Stakeholder Analysis & Management	Basic			Advanced	Intermediate
Strategic Thinking			Intermediate	Advanced	Advanced
Taking accountability					Intermediate
Team Working	Basic		Advanced	Advanced	Advanced
All Behavioural Competencies		Basic			

Table 34: Behavioral Competencies identified for ISRO Trivandrum[62]

Functional Competencies – Trivandrum	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Budgeting & Accountability	Basic	Intermediate	Intermediate		Intermediate
Central Civil Conduct Code		Intermediate	Basic		
Data management		Intermediate			
Design thinking					Intermediate
Documentation					Intermediate
E-office		Advanced	Advanced		Intermediate
Financial budgeting & management			Intermediate		
GFR, 2017		Basic	Intermediate		

[62] Source: CBPO, ISRO

Functional Competencies – Trivandrum	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
IFD framework		Basic			
Interfacing skills				Advanced	
IPR		Intermediate			
Knowledge Management		Advanced			
Lab Management			Intermediate		
Monitoring and evaluation					Advanced
MS office	Advanced	Advanced		Advanced	Intermediate
NIC applications		Intermediate			
Office protocols		Intermediate			Basic
PFMS					Advanced
Presentation skills				Intermediate	
Private participation		Basic	Advanced	Advanced	Intermediate
Process improvement					Advanced
Procurement	Advanced	Basic	Intermediate		Intermediate
Project Appraisal & Management	Basic	Intermediate	Advanced	Advanced	Advanced
Project marketing				Advanced	Advanced
Quality Management					Advanced
Requirement gathering				Advanced	
RTI resolutions					Basic
Safety Awareness			Intermediate		
Science Communication	Basic	Intermediate	Advanced	Advanced	Advanced
Science Diplomacy		Basic		Advanced	Advanced
Social Media		Basic			
Supply chain management	Basic				
Team Management	Basic	Intermediate	Advanced	Advanced	Advanced
Technological advances				Advanced	
Technology fore sighting					Advanced
Technology Management		Advanced			
Techno managerial update				Advanced	
Tender writing	Basic				Intermediate
Time Management					Intermediate
Vendor Management	Intermediate		Intermediate	Advanced	Intermediate
Writing proficiency		Advanced	Advanced	Advanced	
GeM Marketplace	Advanced	Intermediate	Basic	Advanced	Intermediate
ISO - Quality Standards		Intermediate			

Table 35: Functional Competencies identified for Trivandrum

Behavioural Competencies – Ahmedabad	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Accountability					Advanced

Behavioural Competencies – Ahmedabad	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
All Behavioural Competencies		Intermediate		Advanced	
Attention To Detail	Advanced				Advanced
Communication Skills	Intermediate		Advanced		
Conceptual Thinking	Advanced				Intermediate
Conflict resolving strategies	Advanced				
Decision Making	Advanced				Intermediate
Desire For Knowledge	Advanced				
Developing Others	Intermediate				
Empathy					Advanced
Ethics	Advanced				
Initiative & Drive	Intermediate				Intermediate
Innovative Thinking	Advanced		Advanced		Advanced
Integrity	Advanced				
Leading Others	Intermediate				Advanced
Motivation	Advanced		Intermediate		Advanced
Negotiation			Intermediate		
Organizational Awareness	Basic				
People First					Advanced
People Management			Advanced		
Planning & Coordination	Intermediate				Intermediate
Problem Solving	Advanced		Advanced		
Result Orientation	Advanced				
Running Effective Meetings	Intermediate				
Seeking Information	Basic				
Self-awareness and control	Intermediate				Basic
Self Confidence	Advanced				Intermediate
Self-Management	Intermediate				
Strategic Thinking	Intermediate				
Taking accountability					Advanced
Team Working	Intermediate		Advanced		Advanced

Table 36: Behavioural Competencies identified for Ahmedabad

Functional Competencies - Ahmedabad	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Academic Industry Collaboration/ Research			Advanced		Advanced
Budgeting & Accountability	Basic	Intermediate	Intermediate	Intermediate	Intermediate
Central Civil Conduct Code	Intermediate				
Conflict Management					Intermediate
Data analysis and Interpretation			Advanced		

Functional Competencies - Ahmedabad	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Documentation					Advanced
E-office	Advanced	Intermediate			Advanced
GFR, 2017		Basic			
Grammar training for cabinet note, EFC, or office order		Basic			
Knowledge & Technology Transfer			Intermediate		
Mentorship		Advanced			
MS office	Intermediate	Intermediate	Intermediate	Intermediate	
National Anthem, Flag code of India and state emblem of India	Intermediate				
NIC applications	Advanced	Basic		Advanced	Intermediate
Office protocols	Advanced	Basic		Intermediate	Intermediate
Organogram	Basic				
Presentation skills			Advanced		
Private participation	Intermediate	Intermediate		Intermediate	
Procurement & Tendering	Advanced	Advanced	Intermediate	Advanced	Advanced
Project Appraisal & Management	Intermediate	Advanced	Advanced	Advanced	Intermediate
Raj Bhasha	Basic				
RTI resolutions		Intermediate			
Science Communication	Advanced	Advanced	Basic	Advanced	Advanced
Science Diplomacy	Advanced	Intermediate			
Strategic Thinking & Forecasting					Advanced
Team Management	Advanced	Advanced		Advanced	Advanced
Techno managerial update					Intermediate
Vendor Management	Intermediate	Intermediate		Intermediate	
Writing proficiency	Advanced	Advanced	Advanced	Intermediate	Advanced

Table 37: Functional Competencies identified for Ahmedabad

Behavioural Competencies - Bengaluru	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Assertiveness				Intermediate	Advanced
Attention To Detail		Advanced	Advanced	Advanced	Advanced
Commitment to the Organization			Advanced	Intermediate	
Communication Skills		Advanced	Advanced	Advanced	Intermediate
Conceptual Thinking		Intermediate	Advanced	Intermediate	
Conflict resolving strategies		Advanced		Advanced	Advanced
Consultation & Consensus Building				Advanced	

Behavioural Competencies - Bengaluru	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Decision Making	Advanced	Advanced	Advanced	Advanced	Advanced
Delegation	Advanced	Advanced	Advanced	Advanced	Advanced
Desire For Knowledge		Intermediate		Intermediate	
Developing Others				Intermediate	Advanced
Empathy				Intermediate	Advanced
Ethics		Intermediate	Intermediate		
Giving feedback				Intermediate	Advanced
Initiative & Drive		Intermediate	Intermediate		Advanced
Innovative Thinking		Advanced	Advanced	Advanced	Advanced
Integrity		Intermediate	Intermediate		Advanced
Leading Others		Advanced	Intermediate	Advanced	Intermediate
Motivation		Basic		Advanced	Advanced
Negotiation		Advanced	Intermediate	Intermediate	Advanced
Networking skills		Advanced		Advanced	
Organizational Awareness	Intermediate	Intermediate	Intermediate	Intermediate	
People First		Basic	Intermediate		
Planning & Coordination		Advanced	Advanced	Basic	Advanced
Problem Solving	Intermediate	Advanced	Advanced	Intermediate	Advanced
Result Orientation		Advanced	Advanced	Intermediate	Advanced
Running Effective Meetings	Advanced		Advanced	Advanced	Advanced
Seeking Information				Advanced	
Self Confidence		Advanced	Advanced	Basic	
Self-Management		Advanced	Advanced		
Stakeholder Analysis & Management			Intermediate		
Strategic Thinking		Advanced		Advanced	Advanced
Taking accountability		Advanced		Intermediate	Advanced
Team Management	Intermediate				
Team Working		Advanced	Advanced	Advanced	Advanced

Table 38: Behavioural Competencies identified for Bengaluru

Functional Competencies - Bengaluru	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Budgeting & Accountability	Advanced	Intermediate	Advanced	Intermediate	Advanced
Central Civil Conduct Code		Advanced		Advanced	
Collaboration with external stakeholders				Advanced	
Conceptional understanding related to estimation			Intermediate		
Data & Information Security			Advanced	Advanced	

Functional Competencies - Bengaluru	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Data analysis and Interpretation	Advanced				
E-office		Intermediate	Advanced	Advanced	
GeM Marketplace	Intermediate	Advanced	Advanced	Advanced	
GFR, 2017		Intermediate	Intermediate	Intermediate	Advanced
Grammar training for cabinet note, EFC				Advanced	
IPR			Advanced	Advanced	
Knowledge Management	Intermediate		Advanced	Advanced	Intermediate
MS office		Advanced	Advanced	Advanced	
National Anthem, Flag code of India				Advanced	
NIC applications		Advanced			
Office protocols		Basic		Advanced	
Organogram		Basic		Advanced	Advanced
Personnel appraisal				Advanced	
Presentation skills					Advanced
Private participation		Intermediate	Advanced	Advanced	
Procurement and Tender Writing	Advanced	Intermediate	Advanced	Basic	Advanced
Programming skills - Linux, MATLAB	Basic				
Project Appraisal & Management		Advanced	Advanced	Advanced	Advanced
Project Management	Advanced	Advanced	Advanced	Advanced	Intermediate
Raj Bhasha			Intermediate	Advanced	
Risk Analysis & Management			Advanced		
RTI resolutions		Basic		Advanced	
Science Communication	Intermediate	Advanced	Advanced	Advanced	Advanced
Science Diplomacy			Intermediate	Advanced	Advanced
Social Media				Advanced	
Team Management		Advanced	Advanced	Advanced	Advanced
Technical writing	Intermediate				
Technology Management			Advanced		
Vendor Management	Intermediate	Advanced	Intermediate	Advanced	Advanced
Writing proficiency	Advanced	Advanced	Advanced	Advanced	Intermediate

Table 39: Functional Competencies identified for Bengaluru

Behavioural Competencies - Sriharikota	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Accountability	Advanced				
Assertiveness		Advanced	Intermediate		Advanced

Behavioural Competencies - Sriharikota	Scientist/Engineer-SC	Scientist/Engineer-SD	Scientist/Engineer-SE	Scientist/Engineer-SF	Scientist/Engineer-SG
Attention To Detail	Intermediate	Intermediate	Intermediate	Advanced	Advanced
Commitment to the Organization	Advanced	Advanced	Intermediate		Advanced
Communication Skills	Advanced	Advanced	Advanced	Advanced	Advanced
Conceptual Thinking		Intermediate	Intermediate	Advanced	Advanced
Conflict resolving strategies		Advanced	Advanced	Advanced	Advanced
Consultation & Consensus Building	Intermediate	Intermediate			Advanced
Decision Making	Intermediate	Advanced	Advanced	Advanced	Advanced
Delegation	Advanced		Intermediate	Advanced	Intermediate
Desire For Knowledge	Advanced	Advanced	Intermediate	Advanced	Advanced
Developing Others	Intermediate	Basic		Advanced	Advanced
Empathy					Intermediate
Equity					Advanced
Ethics	Advanced		Advanced	Advanced	Advanced
Giving feedback	Advanced	Advanced	Advanced		Intermediate
Initiative & Drive		Advanced	Intermediate	Advanced	Advanced
Innovative Thinking		Advanced	Advanced	Advanced	Advanced
Integrity			Intermediate	Advanced	Advanced
Leading Others	Advanced	Intermediate	Advanced	Advanced	Advanced
Motivation		Advanced	Intermediate		Advanced
Negotiation	Advanced	Intermediate	Advanced	Advanced	Intermediate
Networking skills	Intermediate	Intermediate	Basic	Intermediate	Advanced
Organizational Awareness	Basic	Advanced	Intermediate		Advanced
People First				Advanced	Advanced
Planning & Coordination		Intermediate	Advanced	Advanced	Advanced
Problem Solving	Intermediate	Advanced	Advanced	Advanced	Advanced
Recruitment					Advanced
Result Orientation	Basic	Advanced	Advanced	Advanced	Advanced
Running Effective Meetings	Intermediate	Advanced	Intermediate	Advanced	Advanced
Seeking Information	Advanced	Intermediate	Intermediate	Advanced	Advanced
Self-awareness and control	Intermediate		Intermediate	Advanced	Advanced
Self Confidence	Advanced	Advanced	Intermediate		Advanced
Self-Management	Advanced	Basic	Intermediate		Advanced
Stakeholder Analysis & Management			Advanced		Intermediate
Strategic Thinking	Intermediate	Advanced	Advanced	Advanced	Advanced
Taking accountability		Basic	Intermediate		Intermediate
Team Working	Intermediate	Intermediate	Advanced		Advanced

Table 40: Behavioural Competencies identified for Sriharikota

HSFC - Functional Competency	Scientist/Engineer SC	E-office, GeM, General Financial Rules, MS Office, Project appraisal & Management, Science Communication, Science diplomacy, Team Management, Writing proficiency, Budgeting & accountability, Central civil conduct code, Private participation, Procurement & tender writing, Raj Bhasha, social media, Vendor Management, Grammar training for cabinet note, Office order, Office protocols, Organogram, Public Financial Management System, Financial Literacy & Personal Finance
	Scientist/Engineer SD	Science diplomacy, Team Management, Procurement and tender writing, Project appraisal and Management, Budgeting and accountability, Central civil conduct code, Private participation, Vendor Management, social media, Writing proficiency
	Scientist/Engineer SE	E-office, Grammar training for cabinet note, office order, Team Management, GeM, Science diplomacy, Procurement and tender writing, Science Communication, MS Office, Project appraisal and Management, Vendor Management, Writing proficiency, Budgeting and accountability, Procurement, and tender writing
	Scientist/Engineer SF	Budgeting and accountability, NIC applications, Project appraisal and Management, Team Management, Public Financial Management System, Writing proficiency, Grammar training for cabinet note, office order, social media
	Scientist/Engineer SG	General Financial Rules, Project appraisal and Management, GeM, Writing proficiency, Budgeting and accountability, Private participation, social media

Table 41: Functional Competency identified for HSFC[63]

HSFC - Behavioral Competency	Scientist/Engineer SC	Assertiveness, Attention to detail, Commitment to the Organization, Communication skills, Conceptual Thinking, Conflict solving strategies, Consultation and Consensus Building, Decision Making, Desire for Knowledge, Empathy, Ethics, Initiative and Drive, Innovative Thinking, Leading Others, Motivation, Negotiation skills, Networking skills, Organizational Awareness, People First, Planning and Coordination, Problem Solving, Result Orientation, Self-Confidence, Self-Management, Strategic Thinking, Taking Accountability, Delegation, Team-Working, Integrity, Running effective meetings, Giving feedback, Seeking Information, Stakeholder Analysis & Management, Leadership Skills
	Scientist/Engineer SD	Conflict solving strategies, Consultation and Consensus Building, People First, Strategic Thinking, Problem Solving, Stakeholder Analysis & Management, Delegation, Innovative Thinking, Negotiation skills, Ethics, Planning and Coordination, Conceptual Thinking, Networking skills, Result Orientation, Team-Working
	Scientist/Engineer SE	Conceptual Thinking, Leading Others, Planning and Coordination, Result Orientation, Strategic , Ethics, Negotiation skills, Team-Working, Attention to detail, Communication skills, Consultation and Consensus Building, Decision Making, Organizational Awareness, Integrity, Motivation, Self-Confidence, Strategic Thinking, Empathy, Giving

[63] Source: CBPO, ISRO

		feedback, Initiative and Drive, Organizational Awareness, People First, Self-Confidence, Running effective meetings, Taking Accountability, Commitment to the Organization, Decision Making, Delegation, Developing Others, Networking skills, People First, Problem Solving, Conflict solving strategies, Leading Others, Empathy, Result Orientation, Running effective meetings
	Scientist/Engineer SF	Organizational Awareness, Planning and Coordination, Stakeholder Analysis & Management, Strategic Thinking, Conflict solving strategies, Decision Making, Networking skills, Conceptual Thinking, Result Orientation, Running effective meetings, Attention to detail, Communication skills, Recruitment, Negotiation skills, Team-Working
	Scientist/Engineer SG	Negotiation skills, Strategic Thinking, Assertiveness, Ethics, Consultation and Consensus Building, Decision Making, Planning and Coordination, Running effective meetings

Table 42: Behavioral Competency identified for HSFC[64]

ISTRAC - Functional Competency	Scientist/Engineer SC	E-Office, MS Office, Project Appraisal and Management, Raj Bhasha, Science Communication, Science Diplomacy, Team Management, Budgeting and Accountability, GeM, Private Participation, social media, Vendor Management, Writing Proficiency, Nic Applications, Office Protocols, Procurement and Tender Writing, Project Marketing, Public Financial Management System
	Scientist/Engineer SD	Budgeting And Accountability, GeM, MS Office, Nic Applications, Office Protocols, Procurement and Tender Writing, Project Management, Science Communication, Team Management, Writing Proficiency, E-Office, Raj Bhasha, Science Diplomacy, social media, Vendor Management, Central Civil Conduct Code, Project Marketing, Private Participation, Public Financial Management System, RTI Resolutions
	Scientist/Engineer SE	Budgeting And Accountability, MS Office, Nic Applications, Office Protocols, Procurement and Tender Writing, Project Appraisal and Management, Raj Bhasha, Science Communication, Team Management, Writing Proficiency, GeM, Project Marketing, social media, Vendor Management, Private Participation, Central Civil Conduct Code, E-Office, Organogram, Science Diplomacy, RTI Resolutions
	Scientist/Engineer SF	Budgeting And Accountability, E-Office, GeM, MS Office, Organogram, Private Participation, Procurement and Tender Writing, Project Appraisal and Management, Science Communication, Science Diplomacy, Team Management, Nic Applications, Project Marketing, Raj Bhasha, Vendor Management, Writing Proficiency, Office Protocols, Central Civil Conduct Code, Public Financial Management System, social media
	Scientist/Engineer SG	Budgeting And Accountability, E-Office, Project Appraisal and Management, Science Communication, Team Management, MS Office, Procurement and Tender Writing, Writing Proficiency, Office Protocols, Raj Bhasha, RTI Resolutions, Science Diplomacy, social media, Vendor Management, Nic Applications, Public Financial Management System

[64] Source: CBPO, ISRO

Table 43: Functional Competency identified for ISTRAC[65]

ISTRAC - Behavioral Competency	Scientist/Engineer SC	Attention To Detail, Commitment To The Organization, Communication Skills, Conceptual Thinking, Desire For Knowledge, Equity, Ethics, Innovative Thinking, Problem Solving, Recruitment, Result Orientation, Self-Confidence, Team-Working, Conflict Solving Strategies, Decision Making, Negotiation Skills, Planning And Coordination, Strategic Thinking, Assertiveness, Developing Others, Initiative And Drive, Integrity, Motivation, Seeking Information, Self-Awareness And Self Control, Empathy, Leading Others, Self-Management, Taking Accountability
	Scientist/Engineer SD	Attention To Detail, Commitment To The Organization, Communication Skills, Conceptual Thinking, Decision Making, Desire For Knowledge, Empathy, Equity, Ethics, Initiative And Drive, Integrity, Problem Solving, Team-Working, Assertiveness, Developing Others, Innovative Thinking, Planning And Coordination, Self-Awareness And Self-Control, Self-Confidence, Strategic Thinking, Taking Accountability, Conflict Solving Strategies, Leading Others, Motivation, Networking Skills, Organizational Awareness, Result Orientation, Giving Feedback, Negotiation Skills, Seeking Information
	Scientist/Engineer SE	Assertiveness, Attention to Detail, Commitment To The Organization, Communication Skills, Conceptual Thinking, Conflict Solving Strategies, Decision Making, Desire For Knowledge, Ethics, Initiative & Drive, Innovative Thinking, Integrity, Networking Skills, Planning And Coordination, Problem Solving, Self-Confidence, Strategic Thinking, Team-Working, Developing Others, Empathy, Leading Others, Motivation, Negotiation Skills, People First, Result Orientation, Running Effective Meetings, Self-Awareness & Self Control, Self-Management, Organizational Awareness, Taking Accountability, Equity, Giving Feedback
	Scientist/Engineer SF	Assertiveness, Attention To Detail, Commitment To The Organization, Conceptual Thinking, Consultation And Consensus Building, Decision Making, Innovative Thinking, Integrity, Planning And Coordination, Problem Solving, Self-Confidence, Team-Working, Communication Skills, Desire For Knowledge, Developing Others, Empathy, Ethics, Giving Feedback, Leading Others, Motivation, Organizational Awareness, Result Orientation, Self-Management, Conflict Solving Strategies, Initiative And Drive, Running Effective Meetings, Self-Awareness And Self-Control, Strategic Thinking, Negotiation Skills, Taking Accountability

[65] Source: CBPO, ISRO

	Scientist/Engineer SG	Assertiveness, Attention To Detail, Commitment To The Organization, Communication Skills, Conceptual Thinking, Consultation And Consensus Building, Decision Making, Developing Others, Initiative And Drive, Integrity, Motivation, Self-Confidence, Self-Management, Strategic Thinking, Conflict Solving Strategies, Delegation, Giving Feedback, Innovative Thinking, Leading Others, Networking Skills, Planning And Coordination, Seeking Information, Team-Working, Desire For Knowledge, Empathy, Ethics, Problem Solving

Table 44: Behavioral Competency identified for ISTRAC[66]

MCF - Functional Competency	Scientist/Engineer SC	Large Scale Software Developments, Nic Applications, Office Protocols, Procurement And Tender Writing, Project Marketing, Raj Bhasha, Science Communication, Team Management, Artificial Intelligence & Machine Learning, E-Office, GeM, MS Office, Project Appraisal And Management, Public Financial Management System, Science Diplomacy, Budgeting And Accountability, Spacecraft Dynamics, Vendor Management, Robotics Design, Advanced Coding, Functional Programming, Grammar Training For Cabinet Note, Office Order, Social Media, Writing Proficiency
	Scientist/Engineer SD	7 Quality Tool, Budgeting And Accountability, GeM, MS Office, Network Design, Nic Applications, Office Protocols, Power Distribution Design And Analysis, Procurement And Tender Writing, Project Appraisal And Management, Raj Bhasha, Robotics Development, Science Communication, Science Diplomacy, Team Management, Writing Proficiency, Cyber Security , Deep Learning, Electrical Data Collection And Analysis, Public Financial Management System, Vendor Management, Database Management Tools, E-Office, General Financial Rules, Graphics Development, Private Participation, Programming Proficiency, Purchase Rules And Procedures, RTI Resolutions, Scada And Web Development, Web Development, Information Of Mission Architecture And Software's, Linux RHEL Advanced Skills, Parallel Programming, Power System And Circuit Simulators To Analyze , RTI Resolution, Social Media, Advanced Programming, Artificial Intelligence And Machine Learning, Big Data, Central Civil Conduct Code, Spacecraft Controlling, Monitoring And Analysis , Statical Quality Control

[66] Source: CBPO, ISRO

	Scientist/Engineer SE	Artificial Intelligence Based Analysis Tools And Contingency Handling, Budgeting And Accountability, Cloud Computing And Applications, E-Office, Gem Marketplace, General Financial Rules, 2017, MS Office, Nic Applications, Procurement And Tender Writing, Project Appraisal And Management, Public Financial Management System, Reliability Assessment Tools Learning, Science Communication, Science Diplomacy, Team Management, Writing Proficiency, Office Protocols, Quality Protocols Implementation Methodology, Vendor Management, Real-Time Software Development And Distributed Programing, Science Communication, Automation Design And Development, Critical Analysis And Troubleshooting Skills, Cyber Security Expertise, Operating System Administration, RTI Resolutions, Satellite Attitude Dynamics, Social Media, Automation Framework, Central Civil Conduct Code, Deep Learning And Big Data Analysis, Modeling And Simulation, Networking And Cyber Security, Project Marketing, Risk Assessment And Management, Spacecraft Attitude Control Analysis Using Simulator Tools
	Scientist/Engineer SF	Artificial Intelligence Based Analysis Tools and Contingency Handling, Communication Skill , E-Office, Gem Marketplace, General Functional Management Training at Engr-Sf Level Provided by ISRO, HR Management, Nic Applications, Office Protocols, Project Appraisal and Management, Project Management, Project Marketing, Team Management, Installation, Commissioning, Operation and Maintenance of Ht and Lt Electrical Installation, Preparation Of Technical Specifications for The Electrical Systems and Procurements, Managing The Team for Operation and Maintenance of The Systems, Planning And Executing The Electrical Works For Major Facilities , Automation Framework, Budgeting And Accountability, MS Office, Organizing And Task Management, Procurement And Tender Writing, RTI Resolutions, Science Communication, Team Assistance, Writing Proficiency, Artificial Intelligence Based Satellite Data Analysis Tools , Building Effective Teams, Mission Management, Planning And Coordination, Science Diplomacy, Advance Programming Language, Central Civil Conduct Code, Decisiveness, General Financial Rules, It Security Management, Management And Leadership Skills, Social Media, Vendor Management, Advance Astrodynamics And Space Situation Awareness, Critical Thinking Skills, Data Management, Networking Skills, Organogram, Private Participation, Public Financial Management System
	Scientist/Engineer SG	GeM, General Financial Rules, Office Protocols, Project Appraisal and Management, Public Financial Management System, RTI Resolutions, Science Diplomacy, Team Building and Optimization, Team Management, Budgeting and Accountability, E-Office, MS Office, Organizing and Task Management, Private Participation, Science Communication, Management of Large-Scale Projects and Missions, Vendor Management, Procurement and Tender Writing, social media, Resolution of Project Issues

Table 45: Functional Competency identified for MCF[67]

MCF - Behavioral Competency	Scientist/Engineer SC	Attention To Detail, Commitment To The Organization, Communication Skills, Conceptual Thinking, Integrity, Leading Others, Negotiation Skills, Organizational Awareness, Planning And Coordination, Result Orientation, Self-Awareness And Self-Control, Strategic Thinking, Taking Accountability, Team-Working, Consultation And Consensus Building, Decision Making, Ethics, Running Effective Meetings, Self-Confidence, Self-Management, Stakeholder Analysis & Management, Desire For Knowledge, Empathy, Innovative Thinking, Networking Skills, Assertiveness, Conflict Solving Strategies, Giving Feedback, Initiative And Drive, People First, Problem Solving, Seeking Information, Motivation
	Scientist/Engineer SD	Commitment To The Organization, Communication Skills, Conceptual Thinking, Conflict Solving Strategies, Decision Making, Ethics, Innovative Thinking, Leading Others, Man Power Management, Motivation, Negotiation Skills, Networking Skills, Organizational Awareness, People First, Planning And Coordination, Problem Solving, Running Effective Meetings, Self-Awareness And Self-Control, Self-Confidence, Strategic Thinking, Assertiveness, Attention To Detail, Initiative And Drive, Integrity, Leadership Qualities, Result Orientation, Self-Management, Consultation And Consensus Building, Desire For Knowledge, Developing Others, Empathy, Giving Feedback, Inventory Management, Seeking Information, Stakeholder Analysis & Management, Taking Accountability, Team Work, Innovative Approach, Team-Working, Delegation, Diplomacy, Equity
	Scientist/Engineer SE	Commitment To The Organization, Communication Skills, Conflict Solving Strategies, Decision Making, Desire For Knowledge, Developing Others, Financial Literacy, Innovative Thinking, Leading Others, Organizational Awareness, Planning And Coordination, Problem Solving, Running Effective Meetings, Self-Awareness And Self-Control, Self-Confidence, Strategic Thinking, Taking Accountability, Team Work, Attention To Detail, Conceptual Thinking, Consultation And Consensus Building, Delegation, Initiative And Drive, Integrity, Motivation, Negotiation Skills, Networking Skills, Result Orientation, Self-Management, Team-Working, Giving Feedback, Seeking Information, Stakeholder Analysis & Management, Equity, Ethics, People First, Empathy

[67] Source: CBPO, ISRO

	Scientist/Engineer SF	Commitment To The Organization, Communication Abilities, Communication Skills, Conflict Resolution, Consultation And Consensus Building, Decision Making, Desire For Knowledge, Leading Others, Motivation, People First, Planning And Coordination, Problem Solving, Result Orientation, Stakeholder Analysis & Management, Strategic Thinking, Taking Accountability, Team-Working, Assertiveness, Attention To Detail, Conceptual Thinking, Conflict Solving Strategies, Developing Others, Developing Others, Empathy, Ethics, Initiative And Drive, Innovative Thinking, Interpersonal Skills, Negotiation Skills, Organizational Awareness, Self-Management, Self-Development, Adaptability, Networking Skills, Organisation Management, Running Effective Meetings, Seeking Information, Self-Awareness And Self-Control, Self-Confidence, Creativity, Delegation, Giving Feedback
	Scientist/Engineer SG	Attention To Detail, Commitment To The Organization, Decision Making, Delegation, Result Orientation, Strategic Thinking, Team Development, Assertiveness, Conceptual Thinking, Conflict Solving Strategies, Consultation And Consensus Building, Innovative Thinking, Interagency Coordination, Leading Others, Motivation, Organizational Awareness, Planning And Coordination, Desire For Knowledge, Developing Others, Initiative And Drive, Planning And Strategy, Negotiation Skills, Problem Solving, Running Effective Meetings, Seeking Information, Self-Awareness And Self-Control, Self-Confidence

Table 46: Behavioral Competency identified for MCF[68]

NRSC - Functional Competency	Scientist/Engineer SF	Nic applications, organizing talks, E-office, Project Marketing, social media, General Financial rules, Science diplomacy
	Scientist/Engineer SG	Nic applications, Automated project management tools, Budgeting and accountability, Human resource management, Private participation, public speaking, Science Communication, social media, GeM, Private participation, Science diplomacy, Writing proficiency, Vendor management

Table 47: Functional Competency identified for NRSC[69]

NRSC - Behavioral Competency	Scientist/Engineer SF	Continuous learning, Innovative Thinking, Negotiation skills, Strategic thinking, Assertiveness, Communication skills, Conflict resolving strategies, Organizational Awareness, Stakeholder Management
	Scientist/Engineer SG	Conflict solving skills, Desire for knowledge, Leading Others, Negotiation skills, Networking skills, Strategic thinking, Assertiveness, attention to detail, Conceptual thinking, Delegation, Initiative and Drive, Organizational Awareness, Stakeholder analysis & management, System engineering, Consultation and Consensus Building

Table 48: Behavioral Competency identified for NRSC[70]

[68] Source: CBPO, ISRO
[69] Source: CBPO, ISRO
[70] Source: CBPO, ISRO

SAC - Functional Competency	Scientist/Engineer SC	GeM, MS Office, Raj Bhasha, Science Communication, Team Management, Procurement and Tender Writing, Vendor Management, Technical Report Writing, Writing Proficiency, Project Appraisal and Management
	Scientist/Engineer SD	GeM, MS Office, Team Management, Technical Report Writing, Budgeting and Accountability, Tender Writing, Public Financial Management System, Vendor Management, Organogram, Procurement & E-Tendering, Raj Bhasha, Writing Proficiency, Budgeting & Accountability, Office Protocols, Project Appraisal and Management, Science Communication, Science Diplomacy, Project Marketing, RTI Resolutions, Work Progress
	Scientist/Engineer SE	MS Office, Project Appraisal and Management, Project Workflow Knowledge, Science Communication, Team Management, Capability Evaluation, Vendor Management, Writing Proficiency, Gem Marketplace, General Financial Rules, Work Quality Assessment, Budgeting and Accountability, E-Office, Procurement, Time Assessment, Fabrication Workflow Knowledge, Office Protocols, Private Participation, Raj Bhasha
	Scientist/Engineer SF	E-Office, Science Communication, GeM, MS Office, Writing Proficiency, Science Diplomacy, Team Management, Procurement and Tender Writing, Technical Proposals, Procedures, And Documents Writing, Project Appraisal and Management
	Scientist/Engineer SG	E-Office, Project Appraisal and Management, Science Communication, Structural Design Evaluation, Team Management, GeM, Private Participation, Understanding of Mechanical Configuration, Interaction with Different Teams, Nic Applications, Public-Private-Participation, Science Communication, MS Office, Raj Bhasha, Structural Assessment Related to Different Functional Requirements, General Financial Rules, Verbal & Writing Proficiency

Table 49:Functional Competency identified for SAC[71]

SAC - Behavioral Competency	Scientist/Engineer SC	Attention To Detail, Decision Making, Innovative Thinking, Leading the Group, Strategic Thinking, Conceptual Thinking, Conflict Solving Strategies, Problem Solving, Result Orientation, Commitment to The Organization, Developing Others, Communication Skills, Desire for Knowledge, Integrity, Self-Confidence, Self-Management, Conflict Solving, Empathy, Initiative and Drive, Motivation
	Scientist/Engineer SD	Attention To Detail, Ethics, Innovative Thinking, Strategic Thinking, Taking Accountability, Team Management, Commitment to The Organization, Coordination with Other Engineer, Decision Making, Negotiation Skills, Problem Solving, Result Orientation, Conceptual Thinking, Coordination with Contractors, Planning and Coordination, Maintaining Work Culture, Self-Management, Communication Skills, Conflict Solving Strategies, Desire for Knowledge

[71] Source: CBPO, ISRO

	Scientist/Engineer SE	Clear and Lucid Explanation, Communication Skills, Innovative Thinking, Motivation, Self-Confidence, Self-Management, Decision Making, Integrity, Organizational Awareness, Polite, Strategic Thinking, Team-Working, Commitment to The Organization, Conceptual Thinking, Consultation and Consensus Building, Desire for Knowledge, Listening Capability, Clarity of End Objective, Developing Others, Seeking Information, Stakeholder Analysis & Management, Planning and Coordination, Problem Solving
	Scientist/Engineer SF	Conceptual Thinking, Integrity and Ethics, Organizational Awareness, Desire for Knowledge, Strategic Thinking, Innovative and Creative Thinking, Innovative Thinking, Planning and Coordination, Networking Skills, Problem Solving, Team-Working, Attention to Detail, Decision Making, Desire for Knowledge
	Scientist/Engineer SG	Commitment To the Organization, Critical Thinking, Desire for Knowledge, Innovative Thinking, Integrity, Leading Others, Strategic Thinking, Assertiveness, Conceptual Thinking, Decision Making, Problem Solving, Team-Working, Time Management, Communication Skills, Consultation and Consensus Building, Ethics, Persuasive Skills, Planning and Coordination, Initiative and Drive, Self-Confidence, Empathy, Leadership Styles, Result Orientation

Table 50: Behavioral Competency identified for SAC[72]

IISU - Functional Competency	Scientist/Engineer SC	Budgeting And Accountability, E-Office, GeM, MS Office, Nic Applications, Procurement And Tender Writing, Project Appraisal And Management, Raj Bhasha, RTI Resolutions, Science Communication, Science Diplomacy, Team Management, Writing Proficiency, Central Civil Conduct Code, Design And Implementation, General Financial Rules, Grammar Training For Cabinet Note, Office Order, Planning And Defining Requirements, Theoretical And Computational Knowledge, Vendor Management, Office Protocols, Programming Knowledge, Public Financial Management System, Data Analysis, Defining And Achieving Targets, Experimental Knowledge, Theoretical Analysis, Knowledge Enhancement, Private Participation, Social Media
	Scientist/Engineer SD	E-Office, GeM, MS Office, Procurement and Tender Writing, Project Appraisal and Management, RTI Resolutions, Science Communication, Science Diplomacy, Team Management, General Financial Rules, Public Financial Management System, Vendor Management, Writing Proficiency, Budgeting and Accountability, Grammar Training for Cabinet Note, Office Order, Office Protocols, Private Participation, Raj Bhasha, Nic Applications

[72] Source: CBPO, ISRO

	Scientist/Engineer SE	E-Office, GeM, General Financial Rules, MS Office, Nic Applications, Project Appraisal And Management, Project Marketing, Quality Assurance, RTI Resolutions, Science Communication, Science Diplomacy, Team Management, Technical & Scientific System Development , Budgeting And Accountability, Grammar Training For Cabinet Note, Office Order, Office Protocols, Private Participation, Procurement And Tender Writing, Public Financial Management System, Vendor Management, Social Media, Writing Proficiency, Central Civil Conduct Code, Software Quality Management, Knowledge Enhancement
	Scientist/Engineer SF	Budgeting And Accountability, E-Office, Gem Marketplace, MS Office, Project Appraisal And Management, RTI Resolutions, Science Communication, Science Diplomacy, Team Management, General Financial Rules, 2017, Leading Others, Nic Applications, Procurement And Tender Writing, Research And Literature Survey, Vendor Management, Writing Proficiency, Delegation, Office Protocols, Private Participation, Public Financial Management System, Central Civil Conduct Code, Mile Stone Definitions And Planning, Planning And Coordination, Project Marketing, Raj Bhasha, Social Media, Taking Accountability
	Scientist/Engineer SG	Budgeting And Accountability, Central Civil Conduct Code, Gem Marketplace, Leading Others, Project Appraisal And Management, Project Management, Science Communication, Science Diplomacy, Team Management, E-Office, Nic Applications, Office Protocols, Procurement And Tender Writing, Public Financial Management System, Taking Accountability, Delegation, General Financial Rules, 2017, RTI Resolutions, Vendor Management, Developing Others, IFD Framework, MS Office, Writing Proficiency, Innovative Thinking, Planning And Coordination, Private Participation

Table 51: Functional Competency identified for IISU[73]

IISU - Behavioral Competency	Scientist/Engineer SC	Attention To Detail, Conceptual Thinking, Conflict Solving Strategies, Decision Making, Desire For Knowledge, Ethics, Initiative And Drive, Innovative Thinking, Leading Others, Negotiation Skills, Organizational Awareness, Planning And Coordination, Problem Solving, Self-Confidence, Self-Management, Strategic Thinking, Team-Working, Assertiveness, Commitment To The Organization, Consultation And Consensus Building, Developing Others, Integrity, Networking Skills, Result Orientation, Running Effective Meetings, Strategic Thinking, Communication Skills, Delegation, Equity, Self-Awareness And Self-Control, Taking Accountability, Motivation, Seeking Information, Empathy, Giving Feedback

[73] Source: CBPO, ISRO

	Scientist/Engineer SD	Attention To Detail, Commitment To The Organization, Conceptual Thinking, Decision Making, Delegation, Desire For Knowledge, Initiative And Drive, Innovative Thinking, Leading Others, Negotiation Skills, Networking Skills, Organizational Awareness, Planning And Coordination, Problem Solving, Strategic Thinking, Team-Working, Assertiveness, Communication Skills, Consultation And Consensus Building, Developing Others, Result Orientation, Seeking Information, Self-Confidence, Conflict Solving Strategies, Motivation, Self-Awareness And Self-Control, Self-Management, Taking Accountability, Stakeholder Analysis & Management, Ethics, Integrity, Running Effective Meetings
	Scientist/Engineer SE	Commitment To The Organization, Conceptual Thinking, Conflict Solving Strategies, Consultation And Consensus Building, Decision Making, Delegation, Developing Others, Initiative And Drive, Innovative Thinking, Leading Others, Negotiation Skills, Organizational Awareness, People First, Planning And Coordination, Result Orientation, Self-Confidence, Self-Management, Strategic Thinking, Taking Accountability, Team-Working, Assertiveness, Attention To Detail, Communication Skills, Desire For Knowledge, Ethics, Motivation, Problem Solving, Seeking Information, Integrity, Networking Skills, Running Effective Meetings, Negotiation Skills, Self-Awareness And Self-Control
	Scientist/Engineer SF	Commitment To The Organization, Communication Skills, Conceptual Thinking, Decision Making, Delegation, Desire For Knowledge, Developing Others, Leading Others, Networking Skills, Organizational Awareness, People First, Planning And Coordination, Problem Solving, Result Orientation, Running Effective Meetings, Seeking Information, Self-Awareness And Self-Control, Self-Management, Self-Confidence, Strategic Thinking, Strategic Thinking , Team-Working, Attention To Detail, Conflict Solving Strategies, Consultation And Consensus Building, Initiative And Drive, Innovative Thinking, Integrity, Self-Management, Taking Accountability, Assertiveness, Empathy, Giving Feedback, Negotiation Skills, Recruitment, Self-Awareness And Self-Control, Stakeholder Analysis & Management, Problem Solving , Ethics, Motivation, Team Working
	Scientist/Engineer SG	Conflict Solving Strategies, Desire For Knowledge, Developing Others, Innovative Thinking, Integrity, Leading Others, Networking Skills, Organizational Awareness, People First, Self-Confidence, Strategic Thinking, Team-Working, Commitment To The Organization, Conceptual Thinking, Decision Making, Negotiation Skills, Problem Solving, Seeking Information, Assertiveness, Communication Skills, Delegation, Planning And Coordination, Result Orientation, Taking Accountability, Attention To Detail, Initiative And Drive, Self-Management, Ethics, Running Effective Meetings, Team Working

Table 52: Behavioral Competency identified for IISU[74]

[74] Source: CBPO, ISRO

CAPACITY
BUILDING
COMMISSION