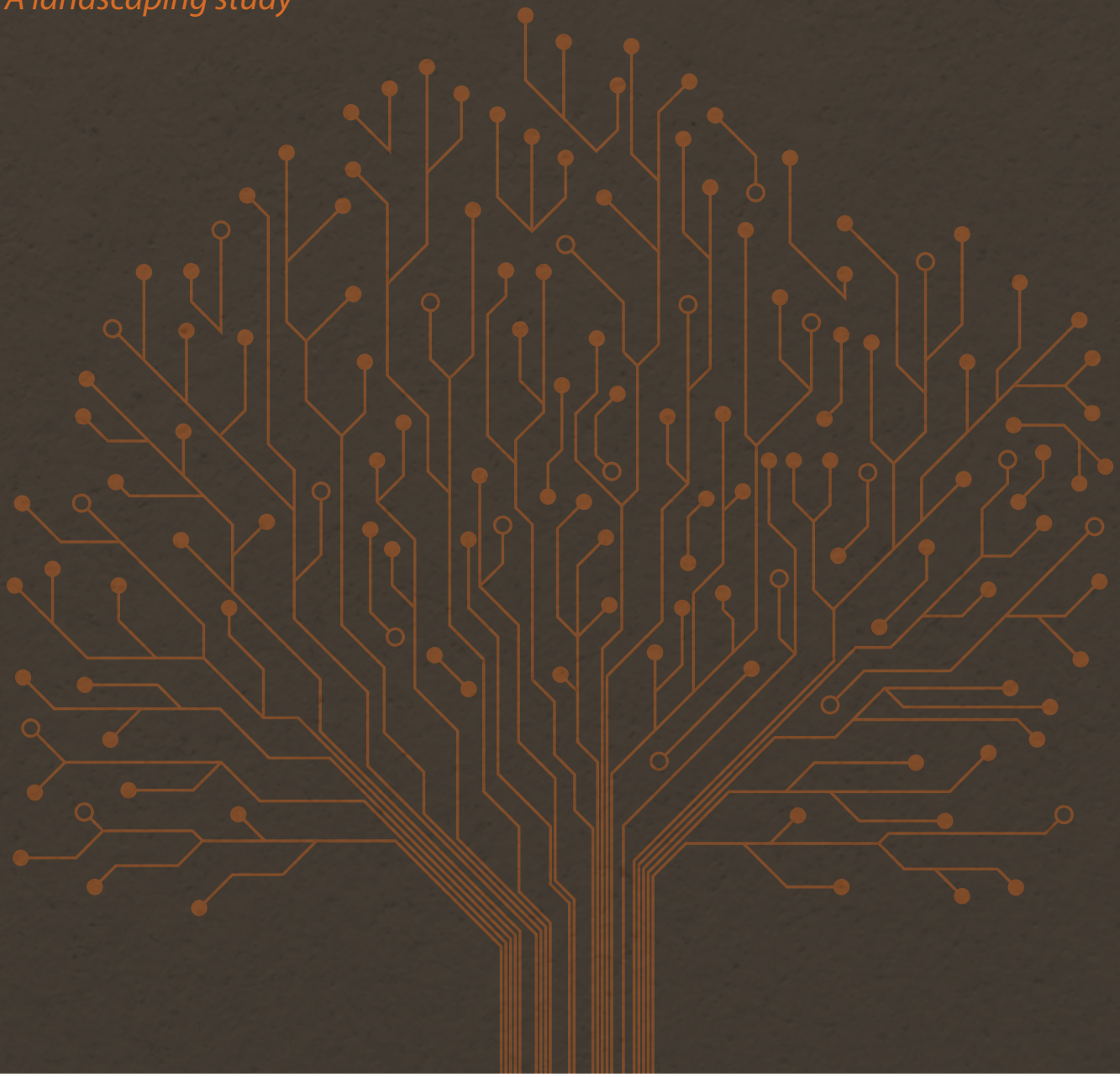
Possibilities for Science, Technology and Innovation Policy Reforms in India

A landscaping study



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Possibilities for Science, Technology and Innovation policy reforms in India

First published in 2022
by Centre for Civil Society

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Please cite the work as follows:
Bhavya Mehta, B. Chagun Basha and Nitesh Anand . 2022 Possibilities for Science, Technology and Innovation policy reforms in India. Centre for Civil Society

Supported by
FAST India and Manipal Foundation
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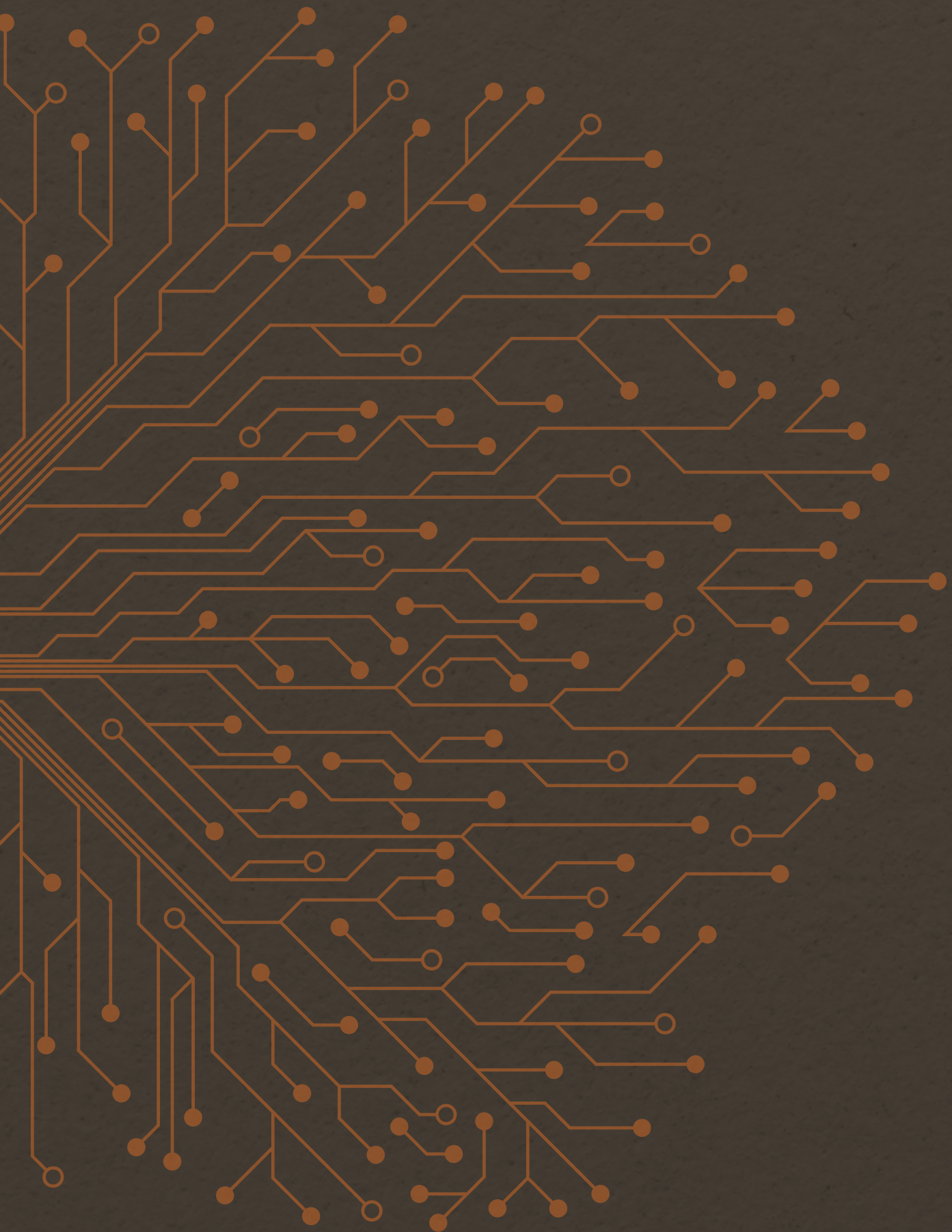


Contents

Abbreviations

AICTE	All India Council for Technical Education
AISHE	All India Survey on Higher Education
BDSASP	Biological Data Storage, Access and Sharing Policy
DORA	San Francisco Declaration on Research Assessment
FDI	Foreign Direct Investment
FTE	Full-time equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GoI	Government of India
I-STEM	Indian Science Technology Engineering and Mathematics (a National Portal)
IDI	In-depth interviews
INFLIBNET	Information and Library Network
NDSAP	National Data Sharing and Accessibility Policy
NRF	National Research Foundation
R&D	Research and Development
RM	Research Management
S&T	Science & Technology
SRIMAN	Scientific Research Infrastructure Management and Networks
STEM	Science, technology, engineering, and mathematics
STI	Science, Technology and Innovation
UGC	University Grants Commission
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
UT	Union Territory

Executive Summary

India's aspiration to transit into a knowledge-based economy is highly dependent on strengthening its Science, Technology, and Innovations ecosystem. Underinvestment in research and development (R&D), debatable quality of the research output, and lack of innovations present significant hurdles in realising the ambition. In the age of rapidly emerging new technology solutions and S&T-based innovations, it becomes critical to proactively (re)shape public policies for the best socio-economic development outputs.

Through this landscaping study, we wish to develop deeper insights and understanding of various perspectives of India's STI ecosystem and identify possible policy action areas that require liberal reforms.

A qualitative scientific methodology was applied to identify indicative perspectives and generated evidence through in-depth interviews with various stakeholders. Discourse analysis, qualitative content analysis, policy prioritization analysis and feasibility analysis were done to arrive at the findings. We engaged with ecosystem stakeholders, independent thought leaders and industry leaders to professors and ecosystem innovators from within the country and abroad. Through this detailed analysis, we identified the following nine specific outcome-focused and action-oriented policy priorities for the STI ecosystem of India:

1. Improving R&D Investment Portfolio
2. Strengthening Critical Base of Scientific Workforce
3. Increasing Access to Frontier Knowledge, Research Data, and Infrastructure
4. Promoting Meaningful & Impactful Research Assessment and Evaluation
5. Facilitating Efficient Research Management Practices
6. Stimulating Utility of Research Outcomes
7. Improving Integration of Research with Higher Education Institutions
8. Re-inventing India's STI Internationalisation Strategies
9. Building Robust Evidence Framework for S&T Policy Planning

The comparative feasibility analysis developed deeper details around the scope of research, possible data or information sources, potential stakeholders to engage, possible impact and outcomes.

Introduction and Background

Advancements in Science and Technology (S&T) play a critical role in transitioning into a knowledge-driven economy. Therefore, countries worldwide are continuously (re)shaping their public policies to better leverage the benefits of scientific knowledge towards achieving socio-economic development priorities. Notably, due to rapidly evolving knowledge frontiers, emerging technologies, and technology-led innovations, it becomes critical to develop dynamic policy interventions.

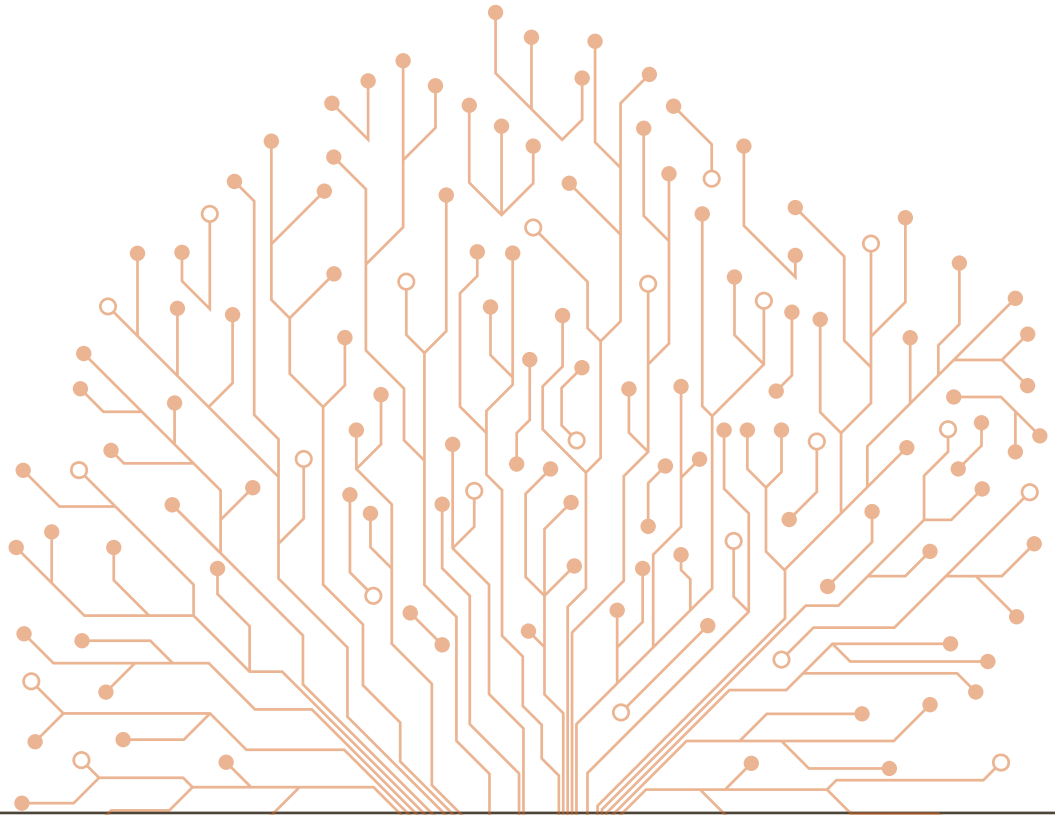
The focus on S&T development has continuously been part of India's post-independence growth story. India spends ~0.7% of its GDP on scientific R&D, of which ~0.4% is spent by the government, and the private sector spends the balance. By contrast, the OECD countries spend an average of 2.3% of their GDP on R&D, with countries like Israel and Korea going well over 4%. India ranks #3 in terms of scholarly publications (quantity) and #9 in terms of publication impact (quality!). While there may be no clear correlation between public investment and research outputs, the underinvestment in R&D in India is also accompanied by poor outcomes in Research: innovation and breakthroughs, patents and science publications. Thus, there are serious challenges in terms of 'quality of research output' and bridging the gap between 'knowledge creation' and 'applying that knowledge for socio-economic value creation.'

India has so far been a services-led economy (54% of GDP). There is a need to balance the dependence of the Indian economy on services with an increase in the share of the manufacturing and agriculture sectors. Stated, the Indian S&T ecosystem, on the one hand, is tightly controlled, lacks autonomy, and is dominated by bureaucratic control and policy ambiguity. On the other hand, there is a lack of accountability and competition among various S&T institutions and actors. This has led to a dearth of high-quality human capital investment in research and institution building, underdevelopment of institutions, relatively poor performance, and lack of cooperation between industry and research institutions. There is a need to strategically increase public funding and private investment in R&D, multiply Full-Time Equivalent (FTE) researchers, build and empower critical infrastructure, facilitate linkages among stakeholders, enable knowledge co-creation, create proper incentives, promote autonomy and improve overall STI governance. India is in the process of creating an intensive new Science, Technology and Innovation Policy (STIP2020), building on the previous four national S&T policies, Scientific Policy Resolution, 1958 (SPR1958), Technology Policy Statement (TPS) 1983, STP2003, and STIP2013.

S&T Policy Vertical at CCS

Centre for Civil Society is India's leading not-for-profit think-tank aimed at advancing social change through public policy. The Science & Technology Policy vertical at Centre for Civil Society (CCS) is dedicated to advancing policy solutions that foster scientific enquiry and research and facilitate the creation and dissemination of new scientific knowledge in India. The vertical aims to strengthen India's science ecosystem and transform people's lives through better policies that promote innovation and scientific advancement.

One of our initial exercises includes understanding how easy it is to do Science/Research in Indian institutions: 'ease of doing science'. By 'ease', we refer to timeliness, simplicity, autonomy, transparency and accountability, predictability of the various processes involved. We also include creation of appropriate incentives, and the accessibility to and availability of various services and tools that enable the pursuit of science.



Methodology

The landscaping study was a qualitative exercise to generate viewpoints and gain insights of various key stakeholders involved directly (or indirectly) in India's STI ecosystem. Following are the methodological steps for the landscaping study:

A. Identification of Indicative Perspective Brackets

Through detailed brainstorming, the S&T policy team arrived at the following ten types of stakeholders indicative perspectives on the STI and policy ecosystem:

1. Institutional Perspective
2. Research Management (RM) Perspective
3. Individual Researcher's Perspective
4. Policy and Governance Perspective
5. Independent Scientific Thought Leadership Perspective
6. Diversity and Inclusion Perspective
7. Knowledge Translation/ Commercialization Perspective
8. Knowledge User/ Industry Perspective
9. Policy Scholar/ Practitioner's Perspective
10. International Perspective

The identification of indicative perspectives provided two distinct assistance to the methodological approach:

- Identify specific stakeholders to provide insights into India's STI ecosystem from various perspectives.
- Develop targeted and relevant questionnaires and interview scripts for generating holistic and multidimensional viewpoints.

B. Identification of Respondents and Conducting IDIs

Approximately 40 stakeholders from various expertise and associations were identified. Out of these 40 stakeholders, we invited 18 stakeholders for IDIs and could get 14 stakeholders to participate in our study. Qualitative in-depth interviews (IDIs) were conducted that generated more than 14 hours of qualitative data, which was further analysed.

C. Data Analysis and Identification of Emerging Policy Priority Areas

Two data collectors recorded the data manually, while interviews were recorded digitally for further collation and transcription. Afterward, a uniquely devised combination of the following three-step data analysis method was administered:

- **Discourse Analysis:** to understand the contextual underlined references and generate adequate insights of individual respondent's qualitative inputs. This was the first step of data analysis and afterwards data entry was made in a uniquely developed entry sheet.
- **Qualitative Content Analysis:** A binary-coded content analysis was done for each of the respondents under each policy theme, and the response was scientifically analysed to provide us the common trends and unique specific insights.
- **Policy Priority Analysis:** This analysis was done based on the emerging trends and identification of key policy priority areas was made through this process.

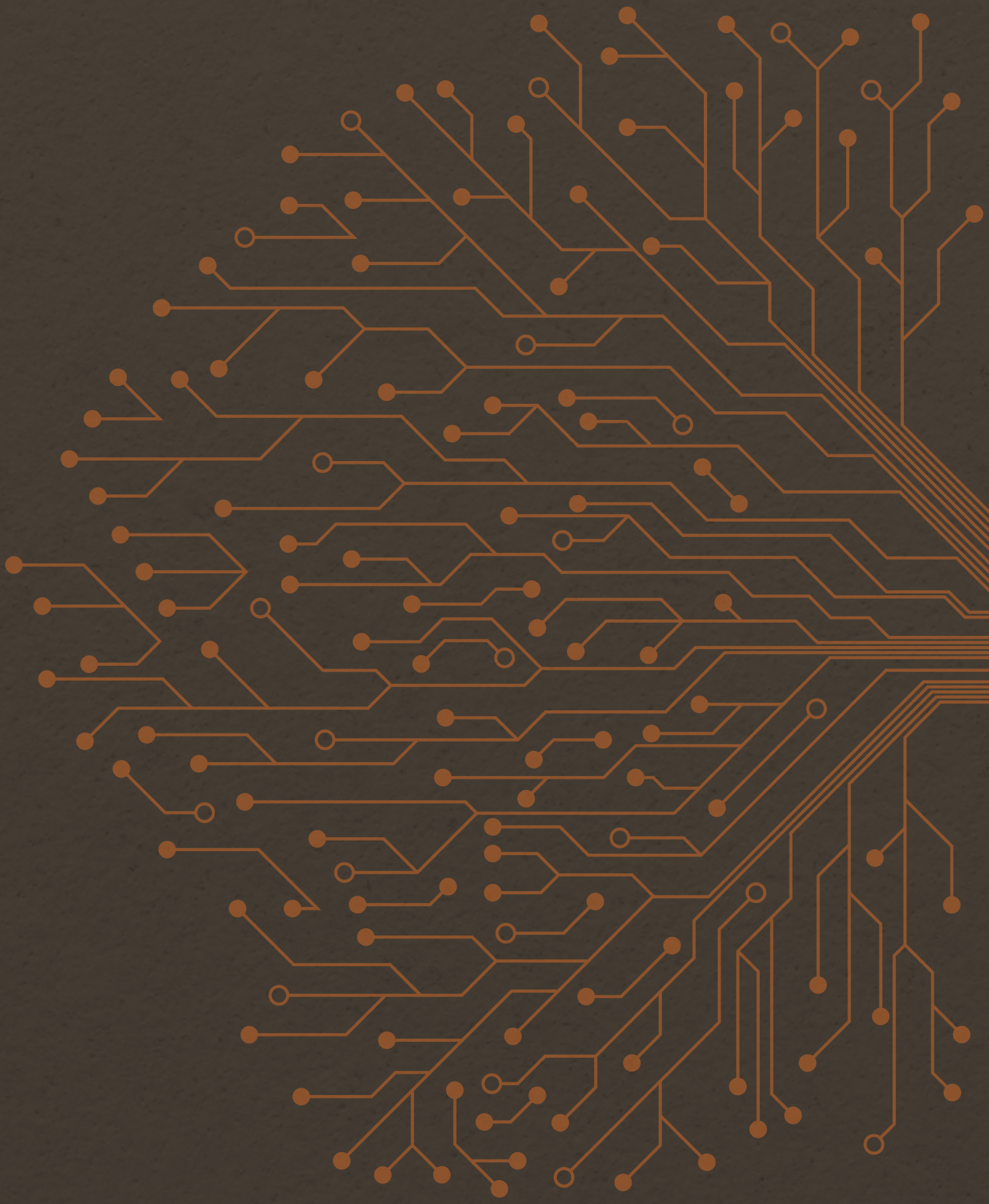
D. Feasibility Analysis

A specific feasibility analysis was done on the identified policy priority areas through the following parameters:

- Potential to create impact
- Effort required to enforce policy change
- Availability of resources and identification of capacity gaps (if any)

Based on the analysis mentioned above, nine policy action areas have been identified, and the details of these are provided further in an analytical form in the report. In addition, these nine policy actions have been analysed on the following parameters to help deepen the understanding as well as initiate constructive discussion on the feasibility of working on any of these policy areas:

- Scope of Research
- Possible Data or Information Sources
- Direct Output
- Potential Stakeholders to Engage
- Possible Impact and Outcomes



Policy Action Priorities

> We need to bring different stakeholders together, and also put the right policies in place. For linking industry, government labs and academia: We do have to change the culture, where we actually incentivize breaking of siloes, don't put one above the other, all are important, and each one has to have skin in the game.

Dr Venkatesh Narayanamurti

Professor; Former Founding Dean, School of Engineering and Applied Sciences and Dean of Physical Sciences, Harvard University (American scientist, public policy leader and academic administrator on the issue of industry and academia collaboration)

> Break from your career (when you have a retirement age), means that you can't progress as far as you could. We can make it as flexible as possible for women to balance between home, family and work. Things are changing, but the question is to make the trajectory faster. Women are also not mentored (there is no old girl's club, unlike old men's club). We need to change the paradigm even with successful women, as they continue mentoring other women scientists. It's a societal issue where women are fed off their inability to lead.

Dr Gagandeep Kang

Microbiologist and virologist
Professor at Christian Medical College, Vellore
(An Indian Microbiologist and virologist on women in STEM)

“There are some things where the investment has to scale with the population. And there are some others where it doesn’t have to. For example, defense expenditure doesn’t scale with population - what you have to spend to protect your country depends on its size, geography, etc but not on how many people live in it. So in that sense, the absolute value of the money is what matters and you have to be careful when you put it as a percentage or per capita. If you want to be competitive in the world, you need to invest a certain amount in science and technology. And that is independent of the population - it is not per capita. The per-capita figure sometimes gives the wrong picture. If you want to be competitive, you have to invest similar amounts irrespective of your population. You may choose to focus on fewer areas, but even if you’re a small country and wish to be the leader in a particular area, you have to spend the same as any other country, small or big.”

Dr Bhaskar Ramamurthi

Director, Indian Institute of Technology Madras
(Director of a top Indian STEM higher education institution on the issue of investment in R&D)

1. Improving R&D Investment Portfolio

Status

There has been a constant policy position, from 2003 onwards, to increase the GERD to 2%. However, there is no systematic study done on funding patterns and sectoral analysis of R&D spending to understand the granular aspects of achieving a considerably higher share of R&D investment.

The funding and expenditure pattern for research and innovation among a) public R&D institutions, b) higher education institutions and c) industrial R&D institutions in the Indian STI ecosystem are addressed under this policy area. Some of the priority issues are:

- Low Gross Expenditure on Research and Development (GERD) (0.69% of GDP)
- Prioritisation of sectoral (by fields and subfields) distribution of R&D investment
- Concentration of research funding opportunities in certain 'eminent' higher education/research institutions; Limited access to research funding in the majority of tier-2 institutions
- Lack of rigorous strategizing in the share of funding towards basic/ fundamental research and applied research.
- Availability of diverse funding sources (central and state public funding, private funding, philanthropic investment and impact investing through corporate social responsibility and foreign direct investment (FDI) in R&D)

There is a need for a strategically crafted long-term vision for India's research and innovation investment plan. It is also pertinent to tackle the issue of bureaucracy as a hurdle in funding and facilitate collaborative models such as public-private partnership funding models for R&D.

Scope of Research

- Fine granular funding pattern & priority analysis with respect to sectors (fields and subfields), institutions, and states.
- Trend analysis of R&D investment activities by various stakeholders

Data Sources

- National R&D Statistics (Biennial)
- FDI Statistics (Quarterly)
- National Innovation Survey (irregular intervals)
- States/UT expenditure on R&D (not readily available)

Stakeholder to Engage

Extramural funding agencies (Centre & States); STI policy advisories

Outcome and Impact Possibilities

- Impact competitive R&D funding schemes
- Attract more private investments into R&D
- Create new models of public-private partnership for R&D
- Create an impact on coordinated funding governance through NRF.

> “There is a need for intervention in the quality of proposals being developed at the state universities and local institutes, by making elite institutes the nodal point to take charge of overall improvement of quality research.”

Dr Chandra Shekhar Sharma

Chair, INYAS; Associate Professor, IIT Hyderabad
(An individual researcher and professor on the issue of concentrated knowledge creation)

2. Strengthening Critical Base of Scientific Workforce

Status

Some major studies/mapping exercises have been done on India's S&T human resource development (during 12th five-year plan). There is scope and need to build a better-nuanced understanding of India's dynamically evolving S&T workforce.

The establishment of research enabling workforce in terms of both quality and quantity are addressed under this policy area.

Some of the priority issues are:

- Gross as well as sectoral quality and quantity of full-time equivalent (FTE) researchers
- Addressing the issue of unemployment among PhDs and other STEM professionals
- Ensuring inclusivity within the scientific workforce
- Existence of robust faculty development programmes to facilitate learning and development
- Issues at the leadership/management and governance levels

Scope of Research

- Studying STEM education pipeline and quality
- Mapping career trajectories of PhDs and Postdocs
- Sectoral mapping of FTE researchers (by fields and subfields)
- Mapping talent mobility across
  - Fields
  - Stakeholders (industry-academia),
  - Institutions and
  - Internationally

Data Sources

- All India Survey on Higher Education (AISHE)
- Higher Education Statistics and Public Information System
- National R&D Statistics
- UNESCO Institute of Statistics (International comparison)

Stakeholder to Engage

All India Council for Technical Education (AICTE), University Grants Commission (UGC), Department of Higher Education (GoI) and Scientific line ministries.

Outcome and Impact Possibilities

- Improve FTE – quantity and quality and through faculty development programs
- create a critical pool of early career researchers (par with global benchmarks) in various priority sectors.

"I don't think there is a need for any big changes in IP [Intellectual Property] laws or mechanisms. The slow process of grants is not a large problem for most people in start-ups; you can license the technology for a start-up even without grants. You should have mechanisms so that people know how to use the IPs. The real issue is lack of human resources with skills to strategise IPs."

Dr Premnath Venugopalan

Head, National Chemical Laboratory Innovations; Director, Venture Center (An innovation & incubation manager and startup mentor on India's intellectual property related mechanisms)

3. Increasing Access to Frontier Knowledge, Research Data and Infrastructure

Status

This policy area is gaining significant traction currently both nationally as well as globally There are transformative agreements signed by countries like Germany, at the same time, UK and France have announced their national Open Science strategies this month (Aug 2021). India is also gearing up towards a unified Open Science strategy.

This policy area addresses the making of frontier knowledge, credible research data and adequate research infrastructure accessible to the scientific research and innovation community of India.

Some of the priority issues are:

- Access barriers to **scholarly knowledge**
- Lack of facilitating platforms for **research data**
- Inadequate **research infrastructure**
- Lack of access to appropriate state-of-the-art research facilities and infrastructure

This priority area includes the discussion of the existent policy measures addressing the access to frontier knowledge through Open Science Policy; access to research data through National Data Sharing and Accessibility Policy (NDSAP) and I-STEM (a national resource sharing portal; access to research infrastructure through the Scientific Research Infrastructure Management and Networks (SRIMAN) and other appropriate existent policies on central and state level of governance.

Scope of Research

- Mapping Open Science initiatives, policies, and strategies worldwide
- Understanding Indian dynamics related to adopting open-access practices to scholarly knowledge and research data.
- Studying the possibilities of shared research infrastructure (cluster-based and otherwise)

Data Sources

- Primary data collection on journal subscription charges
- Research data policies and guidelines: National Data Sharing and Accessibility Policy (NDSAP) and Biological Data Storage, Access and Sharing Policy (BDSASP) etc.
- Scientific Research Infrastructure Management and Networks (SRIMAN) policy and guidelines; I-STEM portal

Stakeholder to Engage

Office of Principal Scientific Adviser to the Government of India, Department of Science and Technology, Information and Library Network (INFLIBNET) Centre "cOAlition S – Plan S", a consortium of national research agencies and funders from twelve European countries

Outcome and Impact Possibilities

- Democratize access to scientific knowledge
- Liberalizing scientific data for expanded utility
- Resource optimization to increase research productivity

> Although outputs are not a sign of outcomes, they can be an indicator of comparative advantage. Strong output can show where an institution might have a global edge - and something useful for those who do value outcomes.

Dr Thomas Barlow

Founder, Barlow Advisory
(An independent thinker, strategic adviser, and global R&D authority talking on the subject of meaningful and impactful research assessment)

4. Promoting Meaningful and Impactful Research Assessment and Evaluation

Status

There is an ongoing debate on how meaningful the existing research assessment and evaluation frameworks are, both in terms of its coverage and impact on individual researchers, institutions and research units. There is no significant policy-focused work done on Indian research assessment frameworks. Although this is a matter of international comparability, context-relevant understanding of such assessment frameworks is highly critical.

The promotion of research assessment and evaluation mechanisms that take into account impact, outcome and the meaningfulness of the research through various indicators, metrics and other evaluation tools and frameworks. Some of the priority issues are:

- Developing a nuanced understanding of the research components; DORA (San Francisco Declaration on Research Assessment), a global standard of how research should be accessed and evaluated can be one of the ways of developing an Indian context-relevant understanding
- Improving on the flaws in the nature of existing research assessment indicators; Addressing the largely subjective nature of the evaluation frameworks
- Existence of comparative indices, composite indicators, outcome-based as well as measuring of meaningfulness aspect of the research activities
- Importance of peer evaluation for research
- Proper usage of the indicators and metrics

Scope of Research

- Understanding the research assessment and evaluation practices at various granularities: individual, research group, institutional, regional, national and international.
- Mapping the linkages among the research assessment and research promotion/incentives.
- Comparative study of various macro and composite indicators of Research

Data Sources

- San Francisco Declaration on Research Assessment (DORA)
- AICTE Research Policy Framework Document
- Institutional research output and performance assessment guidelines (from various technical & scientific institutions in India)
- Terms of References of various awards and competitive grants

Stakeholder to Engage

National Research Foundation (NRF), Council of Scientific and Industrial Research, Ministry of Education, Science & Engineering academies in India (IASc, NASI, INSA, INEA)

Outcome and Impact Possibilities

- Meaningfully change the way research is measured and evaluated.
- Create intelligent policy tools to support Research policy and programs
- Transform the culture of Research (shifting the needle towards quality)

> “Collaborations and consortia are effective ways to expand the scope of research at an institution. They can help to channel expertise and resources from diverse sources towards solving complex research problems.”

Dr Savita Ayyar

Founder, Jaquaranda Tree
(An independent research management consultancy on benefits of collaborations)

5. Facilitating Efficient Research Management Practices

Status

Not much previous work done in this space. Research management is a highly neglected area of work in the STI ecosystem. There is some positive trend in terms of universities in India coming up with full-fledged research management offices. However, there are various policy-level issues that need immediate, critical attention.

This policy area addresses issues related to research management and in turn, seeks to facilitate efficient practices of the same. Some of the priority issues are:

- Lack of an appropriate workforce in taking up research management roles; There is an increasing interest, but the matchmaking to create a pool of people to be absorbed in these roles is also required. There is a need for both apt roles and apt human resources
- Bureaucracy and issues related to the drafting of funding/grant proposals
- Long-term prospects for research management professionals in terms of career progression and evaluation mechanisms to stay and contribute during that long-term
- Training of research managers (pre-award and post-award) and the right group of individuals wanting to attend the program and implement the learnings from the same
- Hesitancy in institutional leadership to make appropriate demands for investments over a longer period
- Creation of proper community engagement channels and platforms for research managers
- Lack of organised research management office instead of general administrative staff
- Need for efficient grant and proposal guidelines from the funding agencies
- Need for digitisation to streamline processes
- Lack of transparency on who sets rules, why they are set and are the set of rules uniform

Scope of Research

- Mapping the components (subheads) of a research grant and estimating what accounts for research management activities. This will have to be an exhaustive work given the diversity of extramural funding sources.
- Understanding institutional policies and guidelines with respect to administrative research management professionals (duration of tenure, subject matter expertise etc)

Data Sources

- Spending related guidelines and notifications from all extramural funding agencies
- Institutional rulebooks and process flows on finances and administration related to research grants
- Proceedings of research councils, hiring/promotion committees, procurement committees etc.

Stakeholder to Engage

National Research Foundation (NRF)/ Office of PSA, India Research Management Initiative (IRMI), NITI Aayog

Outcome and Impact Possibilities

- increase the speed and process efficiency around the research activities
- systemize/automate some of the research-related administrative processes and completely avoid a few unnecessary steps.

"If you are looking at clusters of innovation, we must identify the regions and the institutions where some of the cutting edge work in a specific area is being done. Think ahead. Who are the individuals and organizations in each identified area that are the best in their respective field. Can we identify them and fund them? Because at the end, it is about people and money."

Rajesh Jain

Founder, Netcore
(A technology entrepreneur and pioneer in Asia's dotcom revolution on the issue of S&T innovation)

6. Stimulating Utility of Research Outcomes

Status

This is one of the very common policy areas that is being worked upon by various groups across institutions – particularly, the knowledge commercialization aspects. However, there is still merit in exploring this policy priority with a renewed focus on all 3 aspects of utility of research outcomes (scientific, social, and economic)

This policy area addresses the need for stimulating scientific utility, social utility and economic utility of the outcomes of research activities. It notes that research that has the potential to be converted into something of utility should have the appropriate mechanisms to do so.

- **Scientific Utility:** It includes tackling the issues of the digital divide, language barriers and jargonised science communication
- **Social Utility:** It includes both direct and indirect social innovation through research. (Scientific research might or might not lead to a product in all cases). For example: In order to understand the issue of improper growth of crops the quality of soil as a cause might require delving deep into the issue through research.
- **Economic Utility:** Generating economic value creation by way of startups, product innovations, process innovations, etc.

Additionally, the policy area addresses the gaps between the users and producers of scientific knowledge including but not limited to public and private institutions, individuals and government. It is also pertinent to look at government agencies as users of scientific knowledge through procurement mechanisms of knowledge products.

Scope of Research

- Studying various knowledge co-creation and translation channels among stakeholders including academia, industry and government
- Understanding the concepts of multidisciplinarity, interdisciplinarity and transdisciplinarity from policy perspective
- Studying various Citizen Science and Public Engagement models
- Focused analysis on S&T-led entrepreneurship

Data Sources

- Focused group discussions on/ with stakeholders of Technology Transfer Offices, Research parks and Tech-based incubation centres
- Survey on S&T-led entrepreneurship
- Atal Ranking of Institutions on Innovation Achievements (ARIIA)
- Crossref & Patent databases

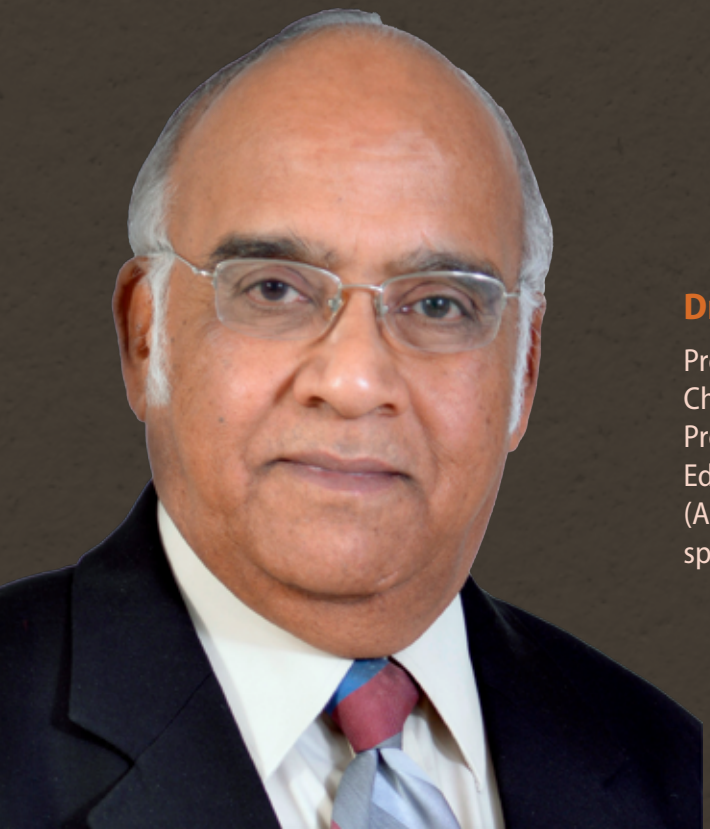
Stakeholder to Engage

Industry associations – CII, FICCI, ASSOCHAM, NASSCOM etc., National Science & Technology Entrepreneurship Development Board, Biotechnology Industry Research Assistance Council (BIRAC), Standalone entities such as IKP Knowledge Park (Hyderabad) and Venture Centre (Pune)

Outcome and Impact Possibilities

- Increase utility of scientific knowledge output (towards socio-economic value creation)
- Attract significant share of best minds towards S&T-driven deep-tech entrepreneurship

"India's ~ 0.7% contribution of GDP to gross R&D expenditure only tells us about supply- side; we must look at the demand-side as well. The number of scientists and engineers active in R&D in India is less than 160 per million population. The demand for R&D resources is very small at this pitifully poor researchers head count. In addition, we must look at industry contribution to R&D. Barring a few honourable exceptions (pharma, automobile), the investment of industry in R&D as a % of sales is woefully inadequate. Industry maturity is still not at a point where its growth is driven by innovation. The industry should increase expenditure on R&D. The Government has initiated several funding calls where industry and academia can join hands and submit proposals. There is a dearth of quality proposals of this type. Our state university system is certainly underperforming. The reasons are many; poor state of state funding, increasing enrolment in terms of sheer numbers, poor permanent faculty to student ratio, inadequate infrastructure, low-emphasis on high quality research, overbearing bureaucracy and political interference. India requires a significant reformation in state funded universities. Indian S&T ecosystems have several islands of excellence, but not a continent. If India's S&T has to make an impact, then there is an urgent need to connect the islands."



Dr Swaminathan Sivaram

Professor; Former Director, CSIR-National Chemical Laboratory, Pune and Honorary Professor Emeritus, Indian Institute of Science Education and Research, Pune
(A scientific institution builder and inventor speaking on the issue of low investment in R&D)

7. Improving Integration of Research with Higher Education Institutions

Status

This, as a policy area, is something new and unique to explore. Although the issue of "majority of research happening outside of higher education setup" is discussed at many places, this is seen primarily as an Indian problem because of legacy issues that led to such dis-integration.

The focus of this policy area is on the integration of research and higher education institutions to build scientific temperament and a systemic culture that values and enhances scientific knowledge.

In India, the majority of research activities take place outside higher education institutions. Building scientific temperament of students and working towards a better alignment to encourage possible collaborative and complementary research with higher education institutions. We also must note that for certain strategic aspects this integration might not be as feasible or appropriate. However, for research degrees in higher education curriculum, having a certain section of the research component would be useful.

Scope of Research

- History and philosophy of doing Science in India.
- Post-colonial understanding of scientific establishments and what led to autonomous stand-alone research institutions
- Studying various possible approaches to improve the 'Research' and 'Higher Education' integration (e.g., Clusters)

Data Sources

- National R&D Statistics (Biennial)
- OECD Datasets on Technical Higher Education
- National Education Policy 2020 – Proceedings of implementation committee meetings.
- Some focused multi-stakeholder consultations

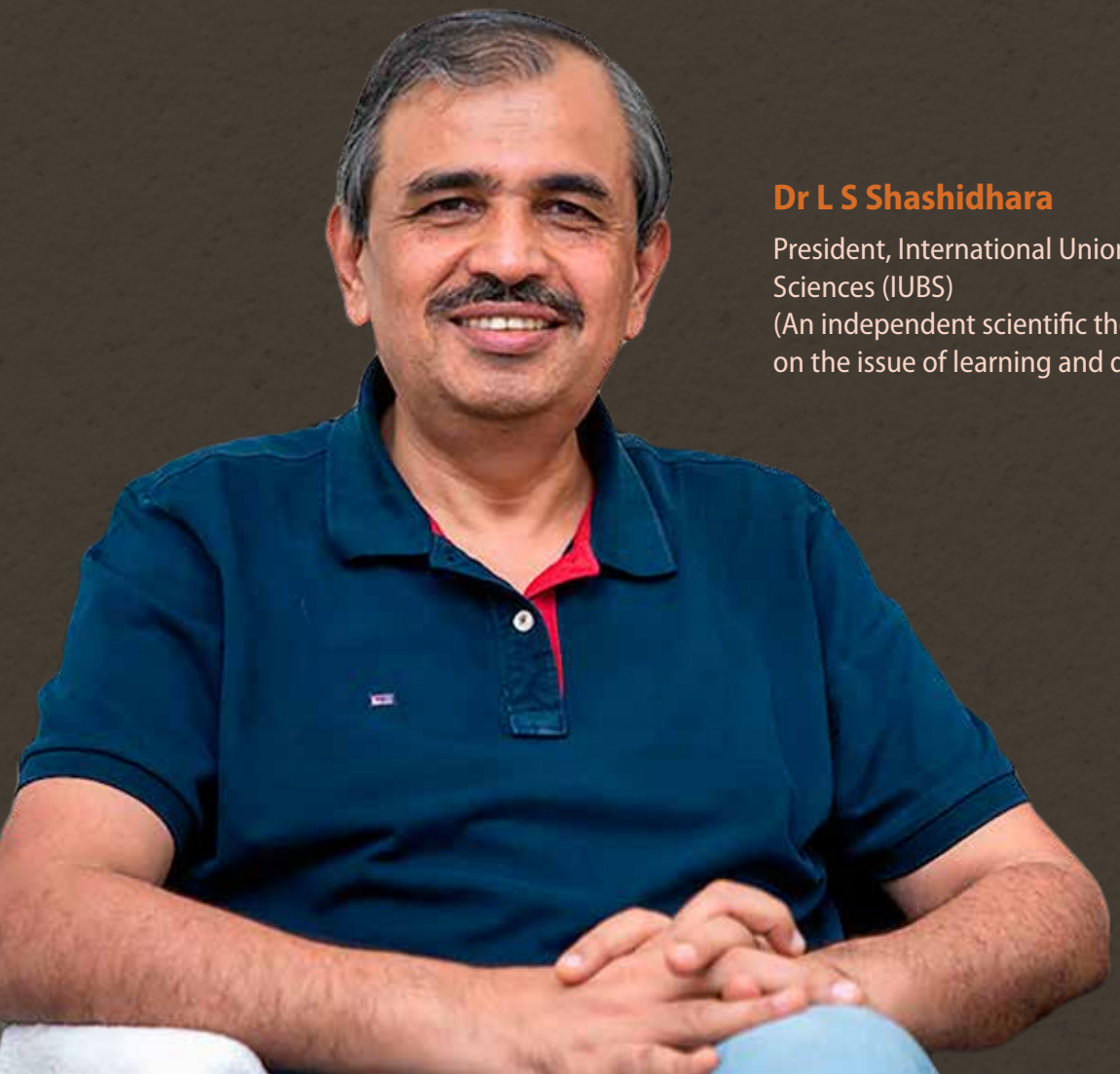
Stakeholder to Engage

University Grants Commission, Department of Higher Education, Ministry of Education, National Research Foundation (and, PM-STIAC pitch, if possible)

Outcome and Impact Possibilities

- Make higher-learning research-intense
- Improve quality of Indian STEM graduates and researchers

> Training the next generation is as important as doing research to ensure continuity of knowledge production. Unless I train other people, after I die, somewhere the chain breaks.



Dr L S Shashidhara

President, International Union of Biological Sciences (IUBS)
(An independent scientific thought leader on the issue of learning and development)

8. Re-inventing India's STI Internationalisation Strategy

Status

This is a highly cross-cutting policy area. A dedicated work on this topic would certainly add value at the intersection of STI and International Engagements. Only a limited set of work is done in this space, that too from the angle of "S&T as a soft power".

India's STI internationalisation strategy focuses on reinventing and strengthening the overall position of India in the Global STI ecosystem through mobility, diplomacy, collaborations and inclusion of appropriate measures such as internationalisation of science and technical institutions. Some of the policy issues are:

- Enhancing international mobility and peer learning aspects
- Increasing India's visibility and control in the international STI ecosystem via an increased involvement in international research agenda-setting
- India's policies for multilateral engagements and regional cooperation
- Enhancing and strategize relation between science and diplomacy
- Internationalisation of science / technical higher education institutions

Scope of Research

- Studying interplay between Science and Diplomacy and developing strategies to leverage diplomatic channels to advance Science.
- Mapping various tools and programs that facilitate internationalization of Indian technical higher education and research institutions.
- Establishing the correlation and causality of how international engagement improves quality of research outcomes.

Data Sources

- National Institutional Ranking Framework (NIRF)
- Atal Ranking of Institutions on Innovation Achievements (ARIIA)
- Datasets from VAJRA (Visiting Advanced Joint Research) Faculty Scheme
- Global Initiative of Academic Networks (GIAN)

Stakeholder to Engage

Multilateral and regional higher education consortiums (such as India-EU Heritage Network, ATOULE etc), Ministry of Education, ITEC, Ministry of External Affairs, International Offices of Universities/ Research Institutions, International Divisions of extramural funding agencies, Bilateral S&T Centres in India

Outcome and Impact Possibilities

- Increase international visibility of Indian Science and Scientists
- Bridge the gaps with international best practices

“There are several sources of funds. Raising funds is not an issue. The processes are the real issue.”

Dr Karishma Kaushik

Asst. Professor, Savitribai Phule Pune University
(A Pune-based researcher and professor on the issue of R&D funding)

9. Building Robust Evidence Framework for S&T Policy Planning

Status

This is a cross-cutting policy area – applicable to the entire spectrum of policy issues that are (or will be) identified. Not much work is done in this area – only a few studies limited to use of bibliometric and patent data in S&T policy planning. A holistic study to prepare an evidence framework for the entire cycle of S&T policy would be useful.

An evidence-based policymaking approach for Indian science and technology is the focus of this policy area.

Some policy issues are:

- Requirement of evidence-based policies instead of political statements
- Need for implementation framework associated with the evidence-based policy
- Inability to give importance to data and ethics of data
- Addressing the demand for evidence behind any pursuit of knowledge and policy proposals

> Societal aspects of science are important considerations in the formulation of holistic science, technology and innovation policies. There is no doubt that India has been doing remarkably well in this field. There is certainly immense potential to do much more. For instance, a need has been felt over time to have in place a systematic and seamless supply chain management system. For instance, it was observed during the SARS-COV-19 pandemic (and especially during the second wave), that the supply chains of food essentials, medical and oxygen supplies were somewhat disrupted. Therefore, holistic policies and academia-government and academia-industry partnerships could be reinforcing mechanisms to strengthen the science and technology ecosystem nationwide

Dr Anjali Taneja

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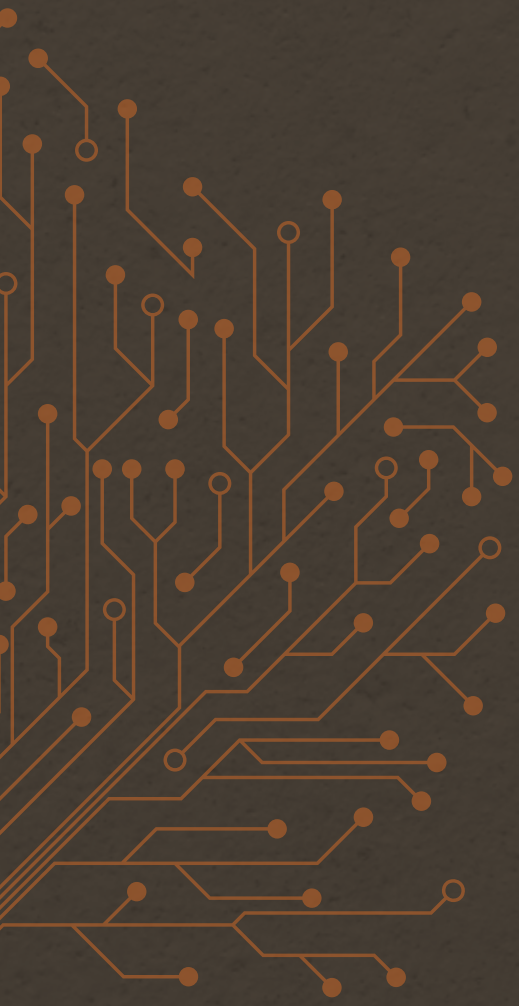

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