Submissions to the

Draft Science, Technology, and Innovation Policy

By CivicDataLab and InternetFreedomFoundation

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Outline of the present submission

As stated in the covering letter, our submission is branched into eight broad headings for convenience and consideration. Each section is a specific cluster that highlights an overarching theme that is divided into specific areas of support and concern after which more granular suggestions are then made. These are namely,

1. Transparency and Accountability
2. Improving inclusion and access
3. Increasing STI Capacity
4. Facilitating Innovation
5. Promotion of Open Science and IP Law
6. Increasing focus on quality of scientific output
7. Open Science and FOSS
8. STI Policy and Sustainable Development Goals

As the world proceeds further into the 21st century, it is clear that the future is digital, and that emerging technologies that hitherto could barely be countenanced will change human lives in a significant way. The National Science Foundation of the US has said that 80% of the jobs that will be created in the next decade will require some amount of mathematical and scientific skills.[1] In such a context, It is imperative that India prepares itself for such a future by possessing a thriving scientific community and a booming technology base. The challenge is to create systems that harness a large number of graduates in the sciences and engineering to improve India's science and technology ecosystem.[2]

To this end, the draft policy represents a significant step towards achieving "individual and institutional excellence in STI". We appreciate the key themes and guiding principles being laid down, and at the same believe a certain amount of granularity in terms of implementation must be added to ensure that the frameworks laid down here actually come to fruition. Furthermore, there remain certain outstanding issues particularly focussed on rights based frameworks which must be addressed. Here, we focus on eight core issues that we feel are of extreme significance.

1. Transparency and Public Accountability : Setting measurable goals

1.1. That four national policies relating to science and technology have been previously formulated, with goals ranging from improving scientific enterprise and scientific temper in the country to achieving technological self-reliance to creating a knowledge based economy to be globally competitive. The draft policy's assessment of the previous policies is that while, "through previous S&T policies, India has been successful in building a

[1] Pagar; *Why STEM education is necessary in the Indian education sector;* The Hindu, March 19th, 2018; https://www.thehindu.com/education/nurturing-innovators/article23279020.ece.

[2] Ramasubramanian; *India falls 4 places in 2020 digital readiness ranking*; The Hindu, October 4th, 2020; https://www.thehindu.com/sci-tech/technology/india-falls-4-places-in-2020-digital-readiness-ranking/article32765558.ece.

robust STI ecosystem.... the new challenges today necessitate a different policy making approach. The current pandemic has catalysed the need for a new policy instrument that amalgamates profound and incremental approaches" (page 10).

1.2 The Draft policy has laid down its own guiding principles. These include: "[t]o achieve technological self-reliance and position India among the top three scientific superpowers in the decade to come" and "To build individual and institutional excellence in STI with the aspiration to achieve the highest level of global recognitions and awards in the coming decade" (page 6).

1.3 While such goals are eminently laudable, without a way to measure these progress towards these goals there is a danger of such outcomes simply remaining words on paper. Thus, it is important that real time metrics be devised to measure the status of implementation of the proposals laid down in this draft policy. This may be done through the proposed national Research Foundation, which could monitor progress and provide prompt feedback to the Department of Science and Technology. Making the details of such evaluations public will also help improve transparency and accountability, as well as provide citizens with a sense of accomplishment towards becoming a scientific superpower.

1.4 However, before implementing this feedback mechanism, a comprehensive evaluation of previous policies must be carried out. Once again, this may be operationalised through the National Research Foundation. This would help guide existing policy by examining the efficacy of previous frameworks and their effectiveness at achieving outcomes.

1.5 While the draft policy acknowledges contributions of previous four national policies - Scientific Policy SPR1958, TPS1983, STP2003, STIP2013 in shaping India's STI ecosystem, its imperative to also measure outcomes of these previous policies, especially key achievements and shortcomings of STIP 2013. We recommend prioritising a holistic data-driven impact assessment of STIP 2013 and major STI related activities mentioned under the 12th Five-year plan (2012-17). This will form an essential foundation to build strategic pathways to realize some of the proposed aspirations of STIP2020.

2. Improving inclusion and access : Focus on reducing discrimination

2.1 Indian academia has long faced questions over the levels of diversity and inclusivity within its ranks. Such questions are asked even more loudly when it comes to STEM fields. Given the vital importance of scientific progress in a developing country, a lack of access to STEM fields for marginalised groups not only closes off a pivotal pathway for social mobility but also fails to take advantage of the 'scientific dividend' a country like India could benefit from.

2.2 These inequalities in access to science play out across different axes. One such differentiation occurs across genders. While on the whole women's enrollment in higher education is increasing, STEM fields remain disproportionately dominated by men. For example, in 2017, the share of male students enrolled in engineering and technology is 71.1% compared to female enrolment, which is just 28.9%.[3] India also has low female to male ratios as first authors, especially for the natural sciences and engineering.[4] Furthermore, as of 2017, there were only 58 females in the position of Reader or Associate Professor for every 100 males, with the ratio for the professorial level being even lower at 37:100.[5]

2.3 Other axes of inequality include caste: across 23 IITs (one of the premier institutes in India), only 9% of the faculty come from SC/ST, or OBC backgrounds as of 2018.[6] Indeed, as of 2019, central government data indicate that this figure may be as low as 2.8%.[7] At IIT Madras, for example, only 7% of the PhD cohort as of 2018 were from SC background, with the figure dropping to 0.8% for STs.[8] If the recommendation of a central government committee to remove reserved posts and seats from the IITs is adhered to, such figures may further reduce.[9] Another such axis is income: for 2009-10 the gross enrollment ratio higher education for the lowest quintile of Indians by income was only 5.22%, compared to 61.71% for the highest quintile (with a national average of 23.05%).[10]

2.4 The policy does a good job of recognising the lack of culture of inclusion as well as the lack of representation and diversity and the absence of institutional mechanisms that facilitate this. Specific proposals that extend the scope of existing policies have already been found to work, such as those

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[3] Pokhriyal; *Enhancing gender equality in India's higher education;* Hindustan Times, March 6th, 2020; https://www.hindustantimes.com/analysis/enhancing-gender-equality-in-india-s-higher-education-opinion/story-CuQKoLDc4ujMGPScy4ejJI.html.

[4] Kulkarni; *Gender Inequality Uniformly High in Indian Academic Publishing*; The Wire, February 19th, 2019; https://thewire.in/the-sciences/gender-inequality-uniformly-high-in-indian-academic-publishing.

[5] Ghosh & Tandon; *A Lot Still Needs to Be Done to Address the Gender Gap in Academia*; The Wire, August 4th, 2018; https://thewire.in/education/women-in-academia-gender-pay-gap.

[6] Ravivanshi; *How Inclusive Is STEM In India? 15 IITs Have No ST Faculty;* Feminism in India, February 27th, 2020; https://feminisminindia.com/2020/02/27/how-inclusive-is-stem-in-india/.

[7] *Less Than 3% of All Faculty Members at IITs Are SC/ST*; The Wire, January 2nd, 2019; https://thewire.in/education/less-than-3-of-all-faculty-members-at-iits-are-sc-st.

[8] Ravivanshi; *How Inclusive Is STEM In India? 15 IITs Have No ST Faculty;* Feminism in India, February 27th, 2020; https://feminisminindia.com/2020/02/27/how-inclusive-is-stem-in-india/.

[9] *NCBC Seeks Inquiry Into Govt Panel's Recommendation to Exempt IITs From Faculty Quotas*; The WIre, January 19th, 2021; https://thewire.in/education/ncbc-inquiry-recommendation-exempt-iit-from-faculty-reservation.

[10] Tilak & Choudhury; *Inequality in Access to Higher Education in India between the Poor and the Rich*; Council for Social Development, 2019; http://www.ecineq.org/ecineq_paris19/papers_EcineqPSE/paper_178.pdf.

provisions mentioned in para 7.2.3 that relate to recruitment, retention, and promotion, will be tremendously helpful. However, while the intention behind designing and implementing such policy interventions is commendable, the draft policy fails to allocate equally distributed focus across all marginalised and disadvantaged groups.

2.5 To create an inclusive culture, emphasis must be on the need for voices from these various disadvantaged communities in the policy design making process itself, and must specify each and every group that would come under the purview of the provisions to ensure that no group is excluded. In addition to have "sensitisation, orientation, counseling" (para 7.2.4) and provisions for "ensuring examination and enquiry of complaints about discrimination"(para 7.2.4), cells and centres similar to the SC/ST cells, as mentioned in the UGC Annual Report 2018-19[11], must also be created as an institutional support system for LGBTQ communities. It is important to establish frameworks and policies that address discrimination and harassment in order to create a safe space and a localised support system.

2.6 To make progress towards equity, we must create a culture of mandatory representation from these communities in the very design of policy frameworks, indicators, initiatives etc. Without hearing from these disadvantaged and marginalised groups themselves and not involving them in such crucial discussions, the policy will fail to be air-tight. Right from design to implementation of assessment of equity and inclusion, it is important to have representation from marginalized communities along with experts.

2.7 Models of education and initiatives on raising awareness on role models and having mentorships from across the globe, that have been successful in promoting and improving representation can be studied to emulate and adapt to the Indian context. The SWAN charter[12] must also be adapted to accommodate the intersectionalities of marginalised and vulnerable communities in the Indian context.

2.8 The UGC Annual Report 2018-19 already lists out various initiatives taken in the direction of fostering inclusivity and diversity like establishment of SC/ST cells, coaching schemes for SC, ST, OBC and minority students, Equal Opportunity Cells (EOCs) etc, paid maternity leave for female doctoral scholars. With well-meaning initiatives in policies already implemented, conducting and publishing impact assessments of these programs is imperative to understanding the pain points and realities, the insights from which can be used to design a more thorough and comprehensive version of this policy.

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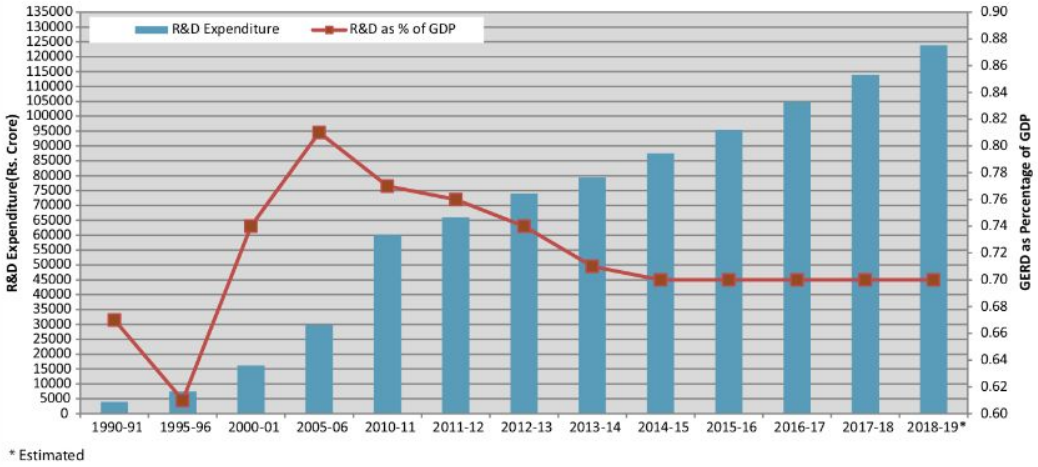
[11] "Annual Report 2018-19", University Grants Commission
https://www.ugc.ac.in/pdfnews/3060779_UGC-ANNUAL-REPORT--ENGLISH--2018-19.pdf

[12] "Athena Swan Charter | Advance HE."
https://www.advance-he.ac.uk/equality-charters/athena-swan-charter

2.9 Having results and data from these impact assessments publicly accessible will also further enhance transparency, accountability and advocacy for equity in STI. Creating an Inclusivity & Diversity index can highlight best practices and encourage national and sub-national institutions to echo and follow these exemples. It will also help provide information to prospective students and academics on whether the institution is a good fit for them.

3. Capacity Building/Financing STI in India

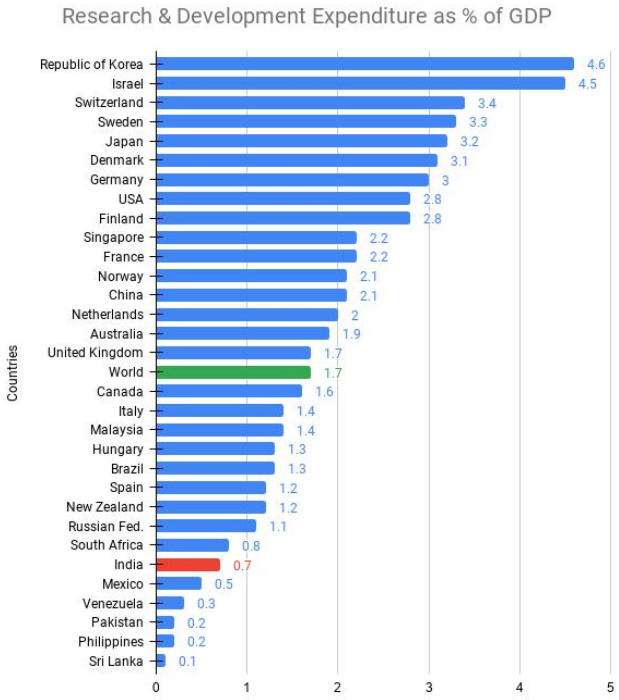
3.1 While the draft policy highlights that India's Gross Domestic Expenditure on R&D (GERD) has been quite low as compared to the developed nations and most of the developing countries, it doesn't set a clear fiscal target for the country to improve the same. As per S&T indicators collected and compiled by NSTMIS, DST, GoI in 2019[13], India's GERD has been stagnant to just 0.7% of the GDP for the last 5 years. When compared to 31 most developing & developed countries, India ranks at a concerning 26th position standing last among the BRICS nations. We propose setting up a fiscal target and roadmap of boosting India's GERD to 1.7% of the GDP coming closer to the current world average.



Source: Research and Development Statistics, 2019-20[14]

[13] DST, GoI, S&T Indicators Tables, 2019-20, https://dst.gov.in/document/reports/st-indicators-tables-2019-20

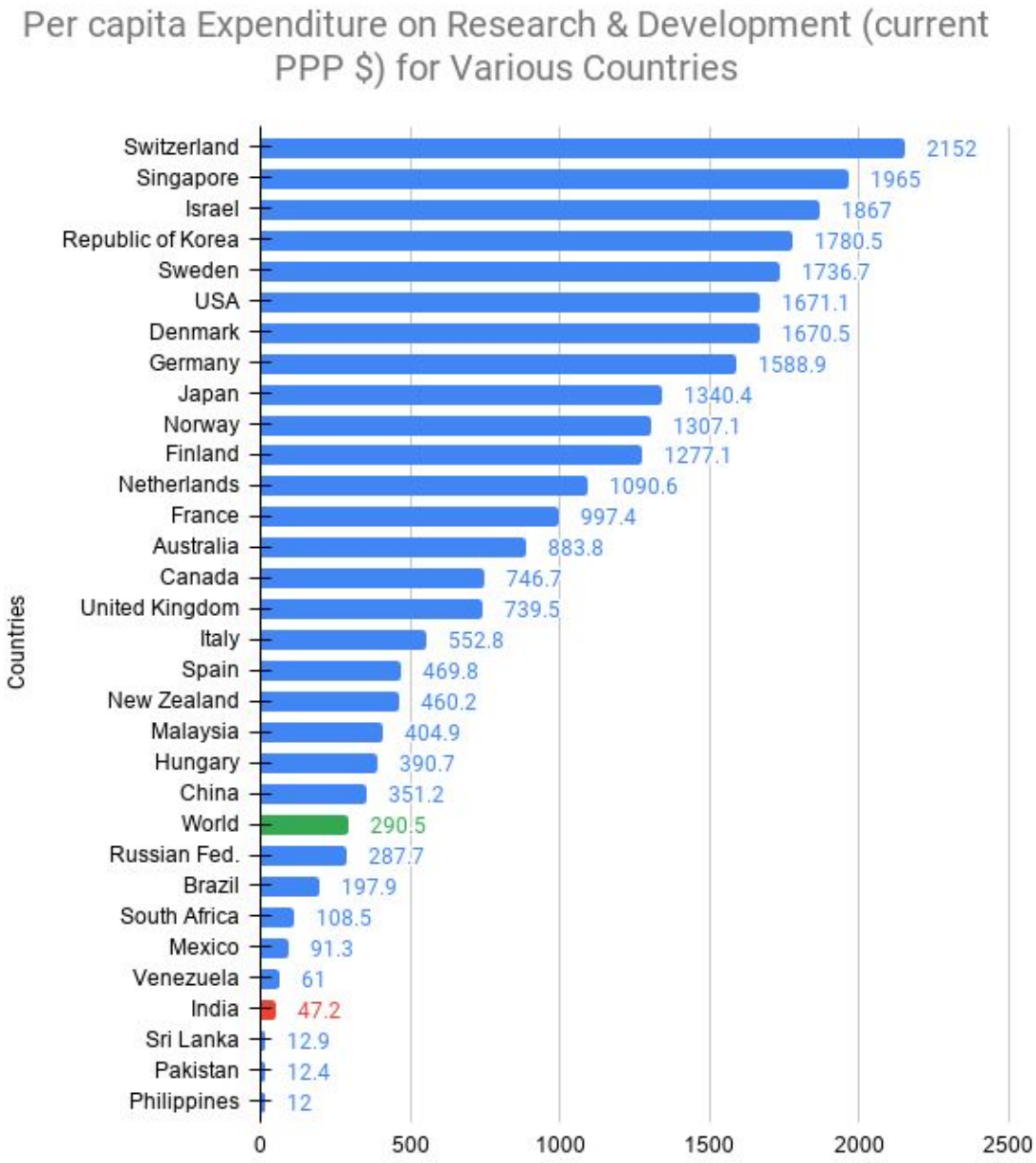
[14] DST, GoI, Research and Development Statistics, 2019-20, https://dst.gov.in/document/reports/research-and-development-statistics-2019-20



Source: S&T Indicators Tables, 2019-20[15]

Further, the S&T indicators highlight the need to set clear fiscal targets to increase India's per capita expenditure on research & development from 47.2 (current PPP$) to 300 (current PPP$) coming slightly above the current world's average in next 5 years.

[15] DST, GoI, S&T Indicators Tables, 2019-20, https://dst.gov.in/document/reports/st-indicators-tables-2019-20



Source: S&T Indicators Tables, 2019-20[16]

4. Facilitating Innovation

[16] DST, GoI, S&T Indicators Tables, 2019-20, https://dst.gov.in/document/reports/st-indicators-tables-2019-20

4.1 One of the effects of having a booming STI ecosystem is a thriving innovation and R&D sector. This helps economies deal with new developments and emerging challenges effectively by channeling new science and burgeoning technologies towards economic growth. In the aftermath of the COVID pandemic, the importance of research and innovation has been made even more clear as the need for new paradigms of work emerges.

4.2 While India has made several strides in recent years, a R&D deficit still remains, especially in the private sector: "In 2004-05, the private sector accounted for 28% of research spend; it was 40% in 2016-17."[17] Indian corporate hesitancy about spending on R&D is well documented, with most private sector entities having "a limited risk-appetite to invest in futuristic technology."[18]

4.3 Globally, India spends way less than its peers on R&D, as we show below. Thus, given that the government is already shouldering most of the R&D load, there is a clear need for making the private sector increase R&D investment.[19] This demand has been echoed by the honourable Prime Minister, who has urged the private sector to increase investment in R&D, especially in fields such as agriculture, defence, space, energy, and construction.[20]

4.4 At the same time, increasing private sector investment should not imply a decrease in public investment. Public investment in R&D is a key driver of innovation. This is because "government institutions, relative to companies, tend to fund broader scientific initiatives that are more likely to lead to more novel discoveries".[21] Also, Corporate innovation has always benefited from publicly conducted or publicly funded research. For example, even a huge private sector entity like Google merged form research conducted during a government funded project.[22]

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[17] *Limits of funding: on private sector research funding*; The Hindu, February 24th, 2020; https://www.thehindu.com/opinion/editorial/limits-of-funding-on-private-sector-research-funding/article30897174.ece.

[18] *Limits of funding: on private sector research funding*; The Hindu, February 24th, 2020; https://www.thehindu.com/opinion/editorial/limits-of-funding-on-private-sector-research-funding/article30897174.ece.

[19] Pulakkat; *Indian R&D needs private sector investment*; The Economic Times, January 12th, 2012; https://economictimes.indiatimes.com/blogs/Sigma/indian-r-d-needs-private-sector-investment/.

[20] ENS Economic Bureau; *PM Modi urges private sector to step up investment in R&D across sectors*; The Indian Express, December 20th, 2020; https://indianexpress.com/article/business/economy/pm-modi-urges-private-sector-to-step-up-investment-in-rd-across-sectors-7111713/.

[21] Blanding; *Corporate Innovation Increasingly Benefits from Government Research*; Harvard Business School, November 12th, 2019; https://hbswk.hbs.edu/item/government-funded-research-is-increasingly-funding-corporate-innovation.

[22] *On the Origins of Google*; National Science Foundation; accessed January 23rd, 2021; https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=100660.

4.5 Indeed, the draft policy also recognises these issues. In this light, the focus on developing a science and technology driven entrepreneurship ecosystem is important, as this will, "[strengthen] the innovation ecosystem" and help to, "attain sustainable economic progress and global competitiveness." Additionally, the focus on indigenous technologies will help stimulate dometic R&D innovation.

4.6 While the aims of adopting a 'Silicon Valley' type model may be commendable, doubts have been raised about the implementation of such a framework in India (infact there exists a wide amount of literature which today urges that such models may be eschewed as they undermine research in foundational sciences towards a focus towards applied sciences).[23] Indeed, it may perhaps be more beneficial to support the organic growth of innovation clusters. Furthemore, future research funding under the Strategic Technology Development Fund should focus on broader scientific research and innovation. Not only would this lead to more comprehensive and profound new technologies, this would also allow a broader set of entities to benefit from this research and allay fears of any innovation monopolies. To stimulate private sector innovation, private enterprises should be mandated to spend a certain portion of gross annual revenue on R&D.

5. Promotion of Open Science and IP Law

5.1 Easy access to scientific literature and resources is essential for scientific research and innovation. This is especially true for developing countries, where existing scientific capacities are not at the level of that of more developed countries. It allows the scientific community to freely engage with the fruits of their own labour, and is a key part of the scientific ethos of open collaboration and shared knowledge.

5.2 In recent times, there has been a clash between this view of science as part of the commons of knowledge and a more Intellectual Property rights based perspective. This 'clash', however, has stemmed not from the scientific community itself, but from the journals that publish scientific papers and articles. This had led to a situation where even Harvard University, one of the premier educational institutions in the world, has been unable to pay the exorbitantly high subscription fees for academic journals.[24]

5.3 Such debates have currently arisen within India as well - the honourable High Court in Delhi is currently hearing a copyright infringement suit filed by several major international publishers against SciHub and LibGen, both of which are websites that provide free access to scientific literature.

[23] Dayasindhu; *Building a vibrant science ecosystem;* The Indian Express, January 12th, 2021; https://indianexpress.com/article/opinion/building-a-vibrant-science-ecosystem-7143793/.

[24] Sample; *Harvard University says it can't afford journal publishers' prices*; The Guardian, April 24th, 2012; https://www.theguardian.com/science/2012/apr/24/harvard-university-journal-publishers-prices.

Many professors and students have already acknowledged their support for SciHub, recognising the importance of unfiltered access to scientific knowledge.[25] This may also make wider revaluation of intellectual property policies and laws which restrict access to knowledge.

5.4 To this extent, we are grateful that the draft policy has taken cognisance of this issue. The creation of the INDSTA portal "to provide access, specifically, to the outputs of all publicly-funded research" is a massive step towards increasing access to scientific knowledge in India, while the 'Open Access' and 'Open Data' policies ensure that publicly funded research remains publicly available. The 'One Nation, One Subscription' policy will reduce the prohibitive subscriptions costs for journals and allow low cost access to high quality science.

5.5 Some concerns still remain, however. The framing of these policies restricts their ambit only to publicly funded research. Given the burgeoning number of private research institutions in the country, such a stipulation would prevent a fair chunk of academic literature from being freely accessed. Thus, it is imperative that free access to all research, whether publicly or privately funded, be provided.

5.6 Additionally, while the 'One Nation, One Subscription' is laudable, several implementation and fundamental challenges exist.[26] Negotiating with the large number of international journals (upwards of 40,000 in number) may not always be a straightforward process. The negotiation process itself must also be subject to scrutiny. Furthermore, such a policy, while of tremendous benefit of those researchers affiliated to universities, may exclude those who lack access to institutional privileges.

5.7 Such an approach also fails to address the key issue of copyrights.[27] Here, the approach can be guided by the Delhi High Court's ruling in *The Chancellors, Masters and Scholars of the University of Oxford and Others v. Rameshwari Photocopy Services and Others, 2016*. Under section 52 (1) (a), (h), & (i) of the The Copyright Act, 1957, the Court refused to restrain a photocopy

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[25] Mudur; *Indian scientists express support for free access to academic research*; The Telegraph, December 12th, 2020; https://www.telegraphindia.com/india/indian-scientists-express-support-for-free-access-to-academic-research/cid/1801693.

[26] Varshney; *Let it flow: COVID-19 pandemic underscores need to share research; but how will it work*; DownToEarth, January 21st, 2021; https://www.downtoearth.org.in/news/science-technology/let-it-flow-covid-19-pandemic-underscores-need-to-share-research-but-how-will-it-work-75131.

[27] Varshney; *Let it flow: COVID-19 pandemic underscores need to share research; but how will it work*; DownToEarth, January 21st, 2021; https://www.downtoearth.org.in/news/science-technology/let-it-flow-covid-19-pandemic-underscores-need-to-share-research-but-how-will-it-work-75131.

shop on the grounds of Delhi University from printing copyrighted material for students.[28]

5.8 Such a progressive interpretation of the law must be the cornerstone of an open access policy. Thus, the draft policy must set forth a legal framework for ensuring that all scientific knowledge can be freely accessed. Such a proposal would also allow existing portals such as Scihub and LibGen to undertake further capacity building in this area, given their relative popularity, and would allow the government to shift it's spending towards promoting high quality science and innovation.

6. Increasing focus on quality of scientific output

6.1 Ultimately, one of the key goals of an STI policy has to be improving not just the quantity but also the quality of scientific output. Scientific achievements have multiple benefits for the country: they are a source of national pride, they make progress towards the constitutional duty of the development of scientific temper, they provide new solutions for societal problems, and provide a spur to the economy.

6.2 India, while having a long history of scientific prowess, has not entirely realised its potential with respect to science. Even though many of our distinguished scientists have made important contributions to the field of science and mathematics, independent India is yet to receive a Nobel Prize for the sciences. Furthemore, many of the aforementioned contributions have been made outside indian academia in foregin institutions, indicating a key deficiency in indian research capabilities.

6.3 Thus, while, given the inequities in access to science, there is a need to improve the quantity of scientific output, without a corresponding increase a quality such efforts will not bear much fruit. At present, India ranks 3rd globally for the number of scientific publications, with the country having experienced a rapid 10.73 rate of growth in publication year on year between 2008 and 2018 - clearly, a relatively greater emphasis must now be placed on improving the quality of our scientific output.[29]

6.4 The draft policy does acknowledge these shortcomings, and expanding the STI system through the Research and Innovation Excellence Framework will greatly help in remedying the same. The sector specific mission mode programmes will help in addressing innovation bottlenecks in key sectors.

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[28] *The Chancellors, Masters and Scholars of the University of Oxford and Others v. Rameshwari Photocopy Services and Others, 2016*; IndianKanoon, December 9th, 2016; https://indiankanoon.org/doc/114459608/.

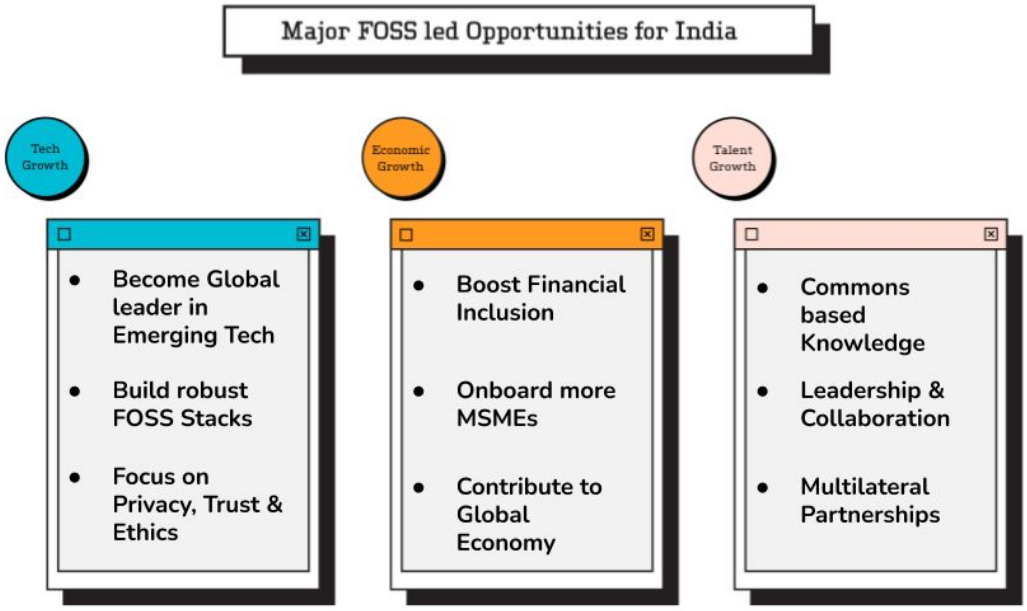
[29] Press Trust of India; *India Is 3rd Globally In Scientific Publications After China, US: Centre*; NDTV, January 23rd, 2021; https://www.ndtv.com/india-news/india-is-3rd-globally-in-scientific-publications-after-china-us-department-of-science-2356847?pfrom=home-ndtv_topstories.

6.5 However, the draft policy does not adequately lay out proposals to improve the quality of 'pure' research. It is vital that each STEM field receive a comprehensive 'research audit' under the aegis of the National Research Foundation. A comprehensive assessment of shortcomings in output and capacity must be undertaken for each field with the help of distinguished practitioners in the field.

6.6 Here, the help of the indian scientific diaspora will be most beneficial. Apart from the steps mentioned to promote home country engagement, the draft policy can make use of the diaspora to provide different global perspectives on improving research in their respective fields.

7. Open Science Framework and FOSS

7.1 We appreciate the proposal of building an Open Science Framework based on Open Data, FAIR principles, Open Access and Open Educational Resources. We propose inclusion of Free and Open Source Software (FOSS) as another key driving principle for this framework. FOSS offers new avenues for economic, technological and talent growth to the STI ecosystem, that are rooted in the commons-based peer production of information, knowledge, and culture. The very ability to tinker, tweak and improve the software is one of the most powerful benefits of FOSS. With the correct implementation of FOSS in STI, India can emerge as a leader in developing technological resources powering global economy and innovation, while at the same time ensuring more inclusion and participation.



Source: The State of Free & Open Source Software Report, 2021[30]

[30] The State of Frees & Open Source Software, CivicDataLab
https://state-of-foss.in/the-state-of-foss-report.pdf

7.2 FOSS technologies provide substantial economic savings compared to equivalent or less functional proprietary tools. A study from 2009 estimates that the tangible savings from using FOSS in schools across India were roughly about Rs.8254 crores[31], these numbers would have gone up multi-folds now. And in addition to software cost, FOSS also helps in building long-term technology capacity and sustainability. Further, recent research suggests that we can achieve overall economic savings of 87% and above for using free and open source hardware (FOSH)[32].

7.3 There is a lack of localized digital literacy curriculum to enable our learners to learn technology in their native languages and support adoption. We face a challenge that most popular operating systems and applications are available only in English. There is a need for localized content to foster widespread adoption of these technologies. Although our research institutes are well positioned to drive creation of localized FOSS initiatives, they currently face major challenges pertaining to resources to lead such programs. Thus, we recommend dedicated funding programs and institutional support for driving localized FOSS Innovations, giving more opportunities to academia, governments, businesses and FOSS communities to come together and co-create.

7.4 FOSS will not just drastically reduce our technological cost of STI initiatives, but will also create a vibrant community of contributors that co-create reusable digital building blocks. We are already witnessing massive adoption of FOSS tools like Tensorflow, Keras, Python, Julia and R in scientific development, research and innovation. However, India still lags behind in the global landscape in building sustainable home-grown projects. Thus, FOSS should be leveraged as essential digital building blocks for the STI ecosystem. We recommend creation of a strategic plan to incubate and proliferate domestic FOSS-led STI innovation in consultation with FOSS communities, academia, businesses and government bodies. Moreover, we strongly recommend publishing of all software created as part of STI initiatives as FOSS licensed under minimally restrictive open source licences[33], especially ones supported by public funding or executed under a public procurement. These must all be open sourced from its initiation towards its further builds.

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[31] Rahul De', Lewin Siwamalai, and Ravi A Rao, "Economic Impact of Free and Open SourceSoftware Usage in Government," June 2015. https://sflc.in/sites/default/files/wp-content/uploads/2016/06/ICFOSS_economic-impact-freev3.pdf

[32] Joshua M. Pearce, Economic savings for scientific free and open source technology: A review, HardwareX, Volume 8, 2020, e00139, ISSN 2468-0672. https://doi.org/10.1016/j.ohx.2020.e00139.

[33] Examples include the GNU All-permissive License, MIT License, BSD licenses, Apple Public Source License and Apache license, more available on Permissive Software License, Wikipedia - https://en.wikipedia.org/wiki/Permissive_software_license

8. STI Policy and the Sustainable Development Goals (SDG)

8.1 We're less than a decade away from the deadline to achieve the 2030 agenda[34]. The United Nations has declared a *Decade of Action*[35], with an urgent call for accelerating efforts towards achieving the SDGs. Fundamental to these efforts is the rethinking of the role of science, finance and policy alike. But beyond progress in each of these areas separately, the interaction between science and policy is critical to tackling global challenges and achieving the SDGs[36].

8.2 In the last 5 years, when the world started to plan its course towards sustainable science by focusing on the Sustainable Development Goals, we, as a country, contributed by focusing on academic rigour, quality, equity in the fields of scientific research. Realising the importance of the STI policy in achieving the SDG's, the United Nations has called for Member States to develop STI roadmaps[37] for each of the SDGs which show the importance of an STI policy as one of the key documents that can help countries stay on course to reach the targets in the desired timelines.

8.3 The current policy (draft) mentions a few key points about how we can keep the SDG's in focus by:

- Identifying priorities for international collaborations,
- Finding ways to upgrade traditional and indigenous technologies that are directed towards the attainment of SDG's.

8.4 The draft policy does not adequately address the importance of having a strong evidence based monitoring mechanism to track the progress in the fields of sustainable development and henceforth tracking our journeys towards the SDG's.

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[34] The 2030 agenda for sustainable development - https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

[35] Decade of Action - https://www.undp.org/content/undp/en/home/stories/decade-of-action.html

[36] On the Importance of the Science-Policy Interface for Achieving the Sustainable Development Goals - http://hdr.undp.org/en/content/importance-science-policy-interface-achieving-sustainable-development-goals

[37] Implementing Science, Technology and Innovation (STI) for SDGs Roadmaps - Operational Note - https://sdgs.un.org/sites/default/files/2020-12/Operation%20Note%20STI%20for%20SDG%20Roadmaps_final_Dec_2020.pdf

8.5 Chapter 4 of OECD Science, Technology and Innovation Outlook 2018[38] states, " the SDGs themselves only reference STI implicitly, rather than explicitly. For example, innovation features explicitly in only one of the Goals, SDG 9: "to build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation". The term "science" is absent in the description of the Goals. Among the 169 targets, 14 targets explicitly refer to "technology", and another 34 relate to goals in technological terms (United Nations, 2015, 2016). The remaining 121 targets include certain technological dimensions, but technology is only one of many means to implement them."

8.6 A strong evidence (data) based infrastructure is needed to better understand the development situation in the country or sector, the possible future development of technology and its application, and what specific indicators should be measured to track progress. Collecting accurate data and building the capacity to assess that data will be necessary in order to develop, implement, and monitor the roadmap. Ideally, any such infrastructure should comply with the Puttaswamy Right to Privacy Judgement within its design and should not be built off personal data without the supervision of a Data Protection Authority.

8.7 India ranks low on the list of global indicators that track the SDG's. One major reason for this is the lack of availability of datasets and standards to measure key data points. For example, in the the Sustainable development report of 2020[39], India ranks lower on Goal 9, one of the important indicators to measure scientific progress. One reason for this could be the data and the approach used in measuring such indicators. Researchers are forced to use such indicators because of the lack of data availability. Moreover, the SDG index dashboard[40] developed by the NITI Aayog misses key indicators that can capture scientific progress at a state level

8.8 It is also necessary to explore the contribution of STI through data at the subnational level. The policy should focus on the approach to curate datasets for important indicators that should be available at-least at a district level. For example, the City of New York's OneNYC[41] has developed indicators based on local data to monitor progress on the SDGs. Secondly, if our goal is to improve the quality of research and scientific education from our state

[38]OECD Science, Technology and Innovation Outlook 2018 - Chapter 4 - STI policies for delivering on the Sustainable Development Goals - https://www.oecd-ilibrary.org/sites/sti_in_outlook-2018-9-en/index.html?itemId=/content/component/sti_in_outlook-2018-9-en

[39] Sustainable development report of 2020 - Dashboard - https://dashboards.sdgindex.org/

[40] SDG Index Dashboard developed by Niti Aayog - https://sdgindiaindex.niti.gov.in/#/ranking

[41] OneNYC - https://onenyc.cityofnewyork.us/

institutes, it will be important to make them a part of the monitoring framework as well.

8.9 It's important, at this stage, to recognise the data deficiencies and work towards having a STI Data Collection and Monitoring roadmap in place that is in alignment with the SDG's. In this regard it is also important to highlight the importance of training policy makers on how to develop, implement, monitor, evaluate, and improve STI for SDG roadmaps.