BROADBAND INDIA FORUM
"Think Tank for Digital Transformation"

BIF Response (Question-wise) to TRAI CP on Encouraging R&D in ICT (Telecom, Broadcasting & IT)

Preamble

BIF an independent think-tank lauds the authority for coming out with a consultation paper on Encouraging R&D in ICT (Telecom, Broadcasting & IT) with the objective to develop a comprehensive eco-system for enhancing R&D and Innovation in ICT Sector of the country, to become a $ 5 trillion Economy with a USD 1 Tn Digital Component inside it.

Some of the issues mentioned in CP are poor research commercialization, low IPR creation, need for increasing contribution of Indian standards in global pool, lack of awareness and protection, deficiency in infrastructure as regards enabling high quality and interactive learning and sub-optimal quality of Education, issues pertaining to IPR Framework, challenges of Government, industry-academia collaboration and inadequate Private investment in the crucial R&D and innovations space (as a % of their revenues) in the ICT sector.

BIF would like to take this opportunity to submit its response and recommendations to address these issues in order to meet the targets and objectives referred to in this CP.

Executive Summary

1. India's ICT sector is experiencing growth with government initiatives for promoting R&D[1]. However, despite a number of the Government's initiatives, measures and schemes, India ranks 40th on Global Innovation

[1] https://dst.gov.in/sites/default/files/Indian%20ICT%20Sectorial%20System%20of%20Innovation%20%28IISSI%29%20Report_0.pdf

Index (GII) 2023 among the 132 economies[2]. One of the primary factors identified for poor GII ranking is the low investment in education sector and expenditure on R&D (as a %age of GDP) much below the global standards. Based on the Research & Development statistics. 2022-23, from Department of Science and Technology, Govt. of India, India's Gross Expenditure on R&D (GERD) is increasing in absolute terms, doubling over a decade from Rs. 60,196.75 crores in 2010–11 to Rs. 127,380.96 crores in 2020–21. GERD as a percentage of GDP has reduced from 0.77% in 2010-11to 0.64% 2020-21[3].

Increased GERD in absolute terms indicates growing investment in R&D, potentially leading to scientific advancements, technological innovations, workforce upskilling, and enhanced global competitiveness. However, decrease in GERD-to-GDP ratio suggests R&D growth is not keeping pace with economic growth, leading to lower R&D intensity compared to other nations, potential limitations in scientific progress, and missed opportunities for economic growth. Hence, needing accelerated R&D growth, enhanced private sector participation, high-impact research, and improved R&D efficiency. India's private sector's contribution to R&D is currently 37%, lower than the US and Germany's 70%. This gap hinders India's innovation ecosystem and technological advancement. Experts suggest aiming for 50-60% of GERD within the next decade to align India with global trends and drive innovation across various sectors.

BIF recommends that R&D funding should be increased to at least 2% of GDP to match it with other countries. It may be noted that India is currently significantly low at 0.66 in contrast to China (2.41), Brazil (1.17), USA (3.42) and many more countries. For fostering innovation, there is need for continuous investment in R&D and innovation processes

[2] https://indbiz.gov.in/india-ranks-40th-on-global-innovation-index/

[3] https://dst.gov.in/sites/default/files/R%26D%20Statistics%20at%20a%20Glance%2C%202022-23.pdf

based on Output-Outcome Monitoring Frameworks (OOMF), ensuring institutional mechanisms to sustain investments and necessary sustainable reforms to make R&D and innovation stay in the forefront of the Indian economy.

2. UNESCO report on Barriers to Higher Education points out that higher education access is not uniform, with the economically underprivileged lagging behind. The Report highlights barriers that include poverty, high tuition fees, exclusive entrance exams, geographic mobility, and socio-economic discrimination. The system needs to motivate and incentivize students to take up academic careers of their interest and choice and to help enable that, Governments should set up an institutional framework to support students to undertake research at the higher level and enhance research and development infrastructure for aiding the interested students to be able to do so, without seeking avenues outside of the country. To overcome this challenge and to promote the overall wellbeing of the PhDs, it is essential for the PhDs to be economically and financially sustainable.

   Modest stipends could make India more competitive internationally and improve the country's research environment. Attracting top talent through attractive stipends could lead to stronger research outputs and advancements. The financial stress for PhD students may be reduced with adequate financial support. In order to ensure, the concern of industry and other funding agencies regarding ensuring research quality, stricter screening and larger stipends would necessitate substantial financial means. Investing in better research facilities, tools, and mentorship could have a positive impact on research infrastructure and support.

3. Out of the 90,000 startups enrolled with the DPIIT programme of ‘Startup India’, almost 50% are in the ICT sector. India's startup sector heavily

relies on ICT and knowledge-based industries, with patents playing a crucial role in digital economy. However, the number of patents granted in India are significantly lower than China, USA, Japan, and Korea. This can be attributed to much lower percentage of the scientific pool which is engaged in research & development, India's low expenditure on R&D, cost of filing and maintenance of patents and procedural delays in granting of the patents etc. Also, India's contributions to the knowledge sector and the IPRs are not considered as valuable as those in other developed countries like China, Korea, Japan, US, etc. due to historical low importance and a general lack of awareness and reluctance to develop patents, though however this trend is now increasingly being reversed of late and more and more Indian contributions are being lauded and accepted in Global Standards Organisations.

Increasing awareness of IPR among researchers and industry professionals in the ICT sector is required. The average pendency for approval in acquiring patents in India is 42 months as of 2020[4]. This is much higher than 20.8, 20, 15.8 and 15 months respectively for USA, China, Korea and Japan. Improving the speed and efficiency of the patent approval process for Information and Communication Technology (ICT) in India is crucial for fostering innovation and ensuring timely protection of intellectual property.

4. Patent filing, winning, and maintenance are costly affairs, making it difficult for startups to invest in global patents. Government could help in this activity. To help meet the declared goal as set by Hon'ble Union Minister for Railways, Communications & IT who has asked at least 10% of the total 6G patents to be from India, Government could help overcome the funding barriers faced by small startups where they are forced to go

[4] https://www.niti.gov.in/sites/default/files/2022-07/India-Innovation-Index-2021-Web-Version_21_7_22.pdf

for unitary patents (in Europe) instead of global patents, in order to save money. Government of India could invest in patent filing in ICT sector through the Telecom Technology Development Fund (TTDF) or other institutions like the newly created Digital Bharat Nidhi through the Telecommunications Act 2023.

5. As per various reports and also as per CP, Quality of higher education is a serious issue which is more predominant in private institutions. Privately managed and privately funded higher education institutions often pay faculty pay scales lower than central government pay scales, leading to hiring of low-quality faculty. The TSR Subramanian report aims to improve India's education quality by entrusting teacher selection to an independent body, promoting technology use, increasing public expenditure, and allocating 6% of GDP for education. It also emphasizes international linkages in higher education, encouraging collaborations and joint research programs.

   It is recommended that Governments-Central & State (since Education is a State subject) should adopt measures to ensure that pay structure for staff/faculty should be uniform for all accredited educational institutions.

6. Continuous interaction between faculty and industry is a must for knowledge sharing, and providing exposure to academic faculty about technologies being deployed by industry. This requires hands-on-training in real environment, joint research projects and industry funded and supported initiatives which are crucial for fostering collaboration between academic researchers and industry experts. Linking of national research laboratories to universities to boost the knowledge and research ecosystem are equally important measures to ensure meaningful research is carried out which have capability of being monetized as well.

7. Research in the digital age requires reliable and ubiquitous digital

infrastructure, digital libraries and databases, access to networks, and access to high speed broadband internet. Provisioning and availability of secure, affordable (preferably free access) broadband connectivity should be the right of every student, and otherwise they run the risk of being left out of the main stream.

8. Currently, there are very few funding opportunities specifically for interdisciplinary research in India. This creates a barrier for researchers who want to pursue interdisciplinary projects, as they often have to compete with traditional disciplinary projects for funding. Some of the recommendations include-

(i) Encouraging joint research initiatives that involve both academic institutions and industry partners.

(ii) Promote the development of cross-disciplinary academic programs that blend ICT with other fields such as biology, economics, and psychology.

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Education and Training System

Q1. Whether current education system adequately promotes scientific temper and skills among students encouraging them to contribute towards Research and Development activities in ICT sector?

If yes, please indicate what additional measures are needed to make them effective contributors of innovations to the industry. If not, please identify areas which need to be strengthened to orient students towards research and development activities in ICT sector.

A1. BIF Response

1.1 The impact of the New Education Policy 2020 on the Higher education system is expected to be far-reaching and transformative5. The NEP 2020 is expected to put India on the track to attain SDG 4 goals[6] of the 2030 agenda for sustainable development by ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all in the next decade. Our education system has faced many challenges. The current education system often emphasizes achieving a high percentage of marks as the focus for the students rather than conceptual understanding of the subject, fostering curiosity, creativity, and problem-solving skills. This can lead to a lack of critical thinking and analytical skills, crucial for R&D."

Some points are summarized below to explain the current state of affairs of R&D and innovations especially in ICT sector.

1.1.1 A 2019 study by the National Council of Applied Economic Research (NCAER) found that only 27% of Indian STEM graduates felt adequately prepared for R&D roles.

1.1.2 The rapid advancements in ICT sectors require specialized skills not adequately addressed in the current curriculum, leading students not prepared for job.

1.1.3 This warrants need for a more practical, research-oriented, and skill-focused education system to adequately prepare students for R&D roles in the ICT sector.

[6] https://sdgs.un.org/goals/goal4

1.1.4 Analysis of Current Education System and Research and Development activities in ICT sector is given in ***Annexure 1***. It is evident from the analysis that the current education system require certain changes and additional measures are needed to make students effective contributors to R&D and innovations to the ICT industry.

1.2. Following are the key suggestions to strengthen the system to orient students towards R&D activities in ICT sector:

1.2.1 As per the study, Comprehensive financial aid packages for PhD programs that include stipend support, tuition waivers, and subsidized health care have the potential to increase overall volume of applications and enhance quality research. Further, it is observed that faculty pay-scales in the privately managed and privately funded higher education institution is not at par with central pay government pay scales. In some cases, it is found that the institutions pay very lower salaries to the faculties or sometimes they pay just basic salaries without dearness allowances and transport allowances etc. and in turn they get low quality faculty.

Therefore, it is proposed that remuneration and incentives to the faculties must be based on an institutionalized system of Minimum emoluments which must be mandated for all institutions-public or private. The disbursement and monitoring of emoluments can be enabled through a centrally managed portal. Any payment below the benchmark payment must not be entertained.

1.2.2 The Indian Space Policy[7] provides freedom of innovation to the private sector via authorization for launch operations, spacecraft operations, ground stations and earth observation data dissemination. It is recommended that the Government should take similar steps for innovation across the ICT sector. To help incentivize and encourage innovations in development of new and cutting edge technologies and products, the concept of Regulatory Sand-Box must be promoted. The Government of India (Department of Telecom) needs to be lauded for legalizing

[7] https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf

this concept of Regulatory Sandbox to foster innovation through the recently notified Telecommunications Act 2023.

1.2.3 Promotion of Interdisciplinary Research: Disciplines in siloes hinder interdisciplinary collaboration, essential for ICT innovations. Govt. of India has taken certain initiatives and innovative steps in this direction.

i. Med-Tech ecosystem in the region to promote R&D activities for development of Medical Devices and providing a platform for Startups, Young Entrepreneurs and Industries. IIT Jodhpur and AIIMS Jodhpur which aims to provide a common platform for doctors and engineers fostering knowledge sharing and innovation leading to development of indigenous healthcare devices and systems through the process of incubation and entrepreneurship.

ii. AYUR-Tech: A unique initiative of IIT Jodhpur, supported by Ministry of AYUSH, is on integrative medicine where Ayurveda and Modern medicine principles for diagnosis and treatment are being investigated together. It also combines Electronics, Digital health and AI and multi-omics approaches for realizing "Evidence based Ayurveda" solutions in a transdisciplinary framework.

1.2.4 Integration of Practical Learning and R&D Project into Practice: National Education Policy (NEP)-2020[8] gives a flexibility to the design of curricula. Universities and institutions must focus on R&D in courseware development to achieve accreditation and ranking, emphasizing research-based learning as a key point for success. Hence, integration of education and research and structural changes are needed. Key areas include integrating practical learning[9], bridging theory-practice gaps, enhancing innovation, fostering a culture of collaboration, and promoting research mindset.

The recommendation is to replace theory courses with project work to allow students to focus on specific projects, allowing

[8] https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

[9] https://files.eric.ed.gov/fulltext/EJ899313.pdf

them to grapple with real-life problems and gain industry value. Faculties should be trained to provide guidance and mentorship for research-oriented projects.

1.2.5 Industry-Academia Collaboration: In spite of all efforts being made by Government to enhance Industry-Academia Collaboration, there is limited collaboration in practice between educational institutions and the ICT industry for enhancing R&D in the sector.

More funding opportunities emphasis to IP generation and clarity in revenue sharing must be provided to accelerate the Industry-Academia collaboration.

Also, the project related to academics must have strong research content rather than development. Also, it has been observed that the expectations from academic research are more towards TRL boosting rather than novelty and fundamental research. Such TRL boosting should be expected from Industry partner rather than academics and the same should be clear while drafting "Call for proposal" by the Government sponsoring agencies.

It would be desirable to have strong and focused linkage between academia and industry when it comes to choice of faculty as industrial exposure should be considered mandatory for choice of faculty and choice of research subjects. Collaboration between education and industry can create valuable opportunities for knowledge exchange, skill development and advancements. The Academia and Industry should forge a strong link to synergise the strengths and mitigate the limitations of each other.

.1.2.6 Research Funding and Infrastructure: India's current R&D spending as a percentage of GDP remains below the global average[10].

To accelerate technological advancements and foster innovation, the government should aim to increase R&D funding to at least 2% of GDP. In addition, funding and expenditure for

[10] https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS

such projects by Industry, should be made eligible for CSR concessions. This significant increase would provide the necessary resources to support cutting-edge research, attract top talent, and establish world-class research facilities.

The research funding through Government sponsoring agencies opt a very slow mechanism in shortlisting, awarding the grant and actual financial transaction. The R&D in ICT sector is highly competitive at global level. Any idea proposed will be obsolete by the time it has been selected for sponsoring if the funding agency takes longer time in evaluating the proposal. This will certainly loose interests in academics where novelty of the research is the main focus considering the outcomes are obtained from PhD research work.

It is also important for Government by itself and to encourage and incentivize Private Institutions to invest in Rural ICT Education Infrastructure.

Few of the suggestions to encourage Interdisciplinary Research are:

a. Establish dedicated funding mechanisms for interdisciplinary research projects. Currently, there are very few funding opportunities specifically for interdisciplinary research in India. This creates a barrier for researchers who want to pursue interdisciplinary projects, as they often have to compete with traditional disciplinary projects for funding.

b. Encourage joint research initiatives that involve both academic institutions and industry partners. Collaboration with industry can provide real-world challenges for interdisciplinary research teams. Researchers should be supported/ mentored by the professors/ experts from respective streams.

c. Integrate interdisciplinary components into academic curricula, allowing students to explore and apply knowledge from various disciplines within ICT programs.

d. Create dedicated research centers that focus on interdisciplinary ICT research. These centers should bring

together experts from diverse fields such as computer science, engineering, mathematics, social sciences, and healthcare (including tradition and modern medicine professionals).

e. Promote the development of cross-disciplinary academic programs that blend ICT with other fields such as biology, economics, and psychology. These programs can offer joint degrees or specializations.

f. Creating a culture of collaboration within the Indian research community. This could involve organizing interdisciplinary conferences and workshops, and by providing funding for researchers to travel to collaborate with researchers from other institutions.

1.2.7 The Continuous Professional Development Program encourages ICT industry professionals to return to academia for advanced degrees or short-term courses, facilitating the flow of industry knowledge back into the education system. The program allocates seats for professionals in each course in colleges/institutions. Addressing the transformative strengths and weaknesses of the Indian R&D ecosystem can create a purposeful and accountable research ecosystem. Following key points can help foster a strong R&D ecosystem:

i. Enhancing Skills and Knowledge: CPD programs provide R&D personnel with the opportunity to acquire new skills and deepen their knowledge in specific areas of expertise, such as artificial intelligence, communications protocols etc.

ii. Fostering Innovation and Creativity: CPD programs expose R&D personnel to the latest advancements, trends, and best practices in their respective fields. This exposure stimulates creativity and encourages personnel to think outside the box, explore new ideas, and develop novel solutions to technological problems. This fosters a culture of innovation and creativity.

1.2.8 India's strong bilateral partnerships with the US and Israel demonstrate the benefits of advanced cybersecurity solutions.

Strengthening these partnerships can be achieved through joint research projects, knowledge-sharing platforms, exchange programs, and technology transfer agreements. India's participation in events like Mobile World Congress and CES showcases its technological prowess and attracts global partnerships.

India should also actively participate in international conferences, workshops, and exhibitions related to IT and telecom. Encouraging researchers and innovators to present their findings at international conferences can attract global attention and investment, positioning the country as a hub for innovation.

1.2.9 In past, PhD students in India used to receive fellowships to cover expenses, helping them to pursue their research, focus on the quality work without hurry and without stress for their necessities. However, universities now charge hefty fees for PhD program, potentially deterring students and impacting national research outcomes.

This trend needs to be reversed through appropriate policy measures and compensation for all research students to adequately meet all their expenses. Only then, we will get higher quality research.

Q2. What should be done to further strengthen the roots of R&D ecosystem in general and specially in the ICT sector of the country, which allows:

a. Increase in number of post-graduates going for doctoral and post-doctoral programs in institutions other than IITs?

A2. BIF Response

Strengthening the R&D ecosystem in ICT sector is paramount to encourage more post-graduates to pursue doctoral and post-doctoral programs in institutions.

2.1 Industry-academia collaboration offers R&D students numerous opportunities for successful careers in research and innovation.

These opportunities include real-world problems, insights into market trends, and the development of relevant problem-solving skills. Students also benefit from access to state-of-the-art facilities, mentorship, and enhancing employability and career prospects. They can build a strong professional network, stand out with practical experience, and potentially secure internships or full-time positions within collaborating companies. Additionally, they can identify commercialization potential for research projects.

Institutions with high-quality faculty and infrastructure can partner with them for contract research, joint research, and recruitment of postgraduates and doctorates. To encourage investment in R&D and recruitment of PhDs, the government should incentivize industry to share the risk of R&D. Without a significant demand for PhD recruitment, the number and quality of PhD students may decline.

2.2 Financial Incentives and Support: Kindly refer *clause no. 1.2.1*

2.3 Early Exposure to Research Opportunities: Early exposure to research activities at the school-level, graduate and post-graduate level provides a foundation and sparks enthusiasm for pursuing further studies at the doctoral and post-doctoral levels. The students may be exposed to the upcoming technologies through open house, science and technology shows, etc.

From 8th grade onwards for every grade, students should be provided with a booklet with potential problems to be addressed / research topics relevant to their grade. Storytelling techniques can be used to discuss on the problems at the beginning of the academic year, encouraging their participation, their imagination and motivate them to take action. Student projects should be based on the problems given in the booklet. It is very important to prepare these booklets at the national level with the support of cross domain researchers, educationalists and physiologists and these booklets should be updated every year or two years once.

2.4 Mentorship Programs and Guidance: Establishing mentorship programs where experienced researchers, senior research scholars mentor post-graduate students, would inculcate the culture of research.

2.5 Uncertainty of career after PhD and low pay: Indians researchers get paid very low and even the opportunities to explore their research is pretty low. They have to move away from the country to work on their projects. And thus those people moving away are innovating and benefiting other countries instead of India.

2.6 PhD programs often prioritize theoretical knowledge and in-depth research, leaving graduates equipped for advanced academic pursuits, but potentially lacking the practical skills and industry experience desired by companies. This can include technical skills specific to the industry, but also soft skills like communication, teamwork, and project management.

2.7 Limited opportunities in Research area: In India there are very limited research oriented companies. With a focus on the research, there would be more opportunities leading to more postgraduate going to PhDs.

Problems identified by students for Project work during their under graduation, post-graduation or even for PhD programme should be based on the challenges faced by user agencies, national level challenges or industry relevant problems. It is very important to consolidate macro level problems as a booklet. Rather than choosing some problem which may not have any relevance, this approach helps them to continue to work in future and also such students will be accepted by Industry for job opportunities. Many times the project outcome / PhD outcome is not relevant to any industry / Government job requirements. It is very important to prepare these booklets at the national level with the support of cross domain researchers (including IIT professors), industry experts, educationalists and physiologists and these booklets should be updated every year or two years once. This helps to improve the quality of research outcome.

Enable sufficient open sources/ free tools, tool rooms, testbeds and datasets. Train the faculty from non IITs in IITs, national research labs and industry.

b. Assured career progression opportunities in the field of Research and Development for students graduating from tertiary educational institutions?

2.8 Technological and sectoral changes are causing skills to become obsolete, necessitating lifelong learning to keep up with these changes. Countries are expanding tertiary education systems due to student demand, occupational focus, lifelong learning, and teaching approaches. Tertiary institutions can enhance career progression in ICT R&D by promoting specialization, skill development, industry connections, entrepreneurial mindset, and continuous learning. This proactive approach increases success for aspiring professionals.

2.9 Tertiary colleges aim to challenge rigid university teaching, offering greater student choices and addressing weaknesses. However, differentiation often leads to equity issues, as students from different backgrounds are concentrated in different institutions. Tertiary colleges, often focusing on occupational education, require students to receive employment benefits. Despite criticisms about teaching quality, these colleges have advantages such as small classes, dedicated faculty, industry-based expertise, and work-based learning, which contribute to their success.

2.10 To maximize career progression opportunities in ICT R&D, tertiary institutions should deepen and specialize in specific niches, encourage postgraduate studies, focus on practical skills, bridge the gap to industry, and foster strong partnerships with R&D companies and research labs. This includes integrating project-based learning with real-world applications and facilitating internships, mentorship programs, and career fairs for early career exposure.

c. Researchers to continue entire career in advanced research.

2.11 To strengthen the R&D ecosystem, especially in the ICT sector, researchers should develop a strong research identity, cultivate a diverse funding portfolio, establish long-term collaborations, invest in ongoing professional development, engage in mentorship and knowledge transfer, and ensure consistent and long-term funding commitment.

2.12 Fostering long-term collaborations with other researchers, institutions, and industry partners enhances the scope and impact of research. Investing in ongoing professional development ensures relevance and positions researchers as leaders in their field. Mentorship and knowledge transfer also contribute to the

development of the research community and leave a lasting impact on future researchers.

2.13 Limited opportunities for researchers to continue entire career in advanced research. Most people will choose research to get government job in national laboratories. Others will choose research path to immigrate in foreign countries.

d. Increase in employability and career progression skills of students enrolled in STEM courses?

To enhance the employability and career progression skills of students enrolled in STEM (Science, Technology, Engineering, and Mathematics) courses, few steps are as given below:

2.14 The curriculum for STEM students should incorporate industry-sponsored research projects, offering students practical experience and exposure to R&D challenges, while mentorship programs provide career guidance, skill development, and networking opportunities. It should cultivate effective communication skills, teamwork, and project management abilities crucial for success in R&D environments, introducing concepts of innovation, commercialization, and intellectual property rights to empower students to translate research into tangible solutions.

2.15 Providing opportunities to engage with practitioners would seem to be a feature of maintaining and building expertise in the STEM education research community. The strategy involves incorporating practical experience, interdisciplinary learning opportunities, and soft skills development into STEM courses. This helps students develop problem-solving, critical thinking, and problem-solving skills. Interdisciplinary learning combines STEM disciplines with other fields, fostering a holistic approach.

2.16 Capacity building exercises should focus on supporting entry and retention of researchers in the profession. Factors facilitating career growth include securing permanent university positions and winning funding for projects. A strong research culture is beneficial for recent researchers. Institutions seeking new researchers and designing fellowship programs should consider providing a solid support structure, especially from senior colleagues. This will help ensure a

successful career in the field.

2.17 One of the issues around less high quality research was a lack of methodological rigor. Therefore, a key issue for a fellowship programme is to develop methodological expertise in the STEM education research community, and to ensure that all have access to high quality training, especially those from a teaching background.[11]

2.18 The government initiative includes enhancing grants and funding through the creation of the National Research Foundation (NRF), to focus on funding meaningful projects, reducing the need for access to multiple sources. However, this funding is limited to a few research scholars for certain projects. Govt. policies, availability of funding and the motivation to advance knowledge and understanding are the key drivers for STEM students to undertake the research.[12]

The startup ecosystem in academic institutions including Tier-1 institute such as IITs should be rigorously supported for R&D and advanced technology driven ideas. Currently, the startup seed funding by most of the incubators are focused on sanctioning small amounts over large number of startups. The ICT technology requires more investment. Therefore, the incubators rather aiming for increased number of startups should focus more on few advanced technologies driven R&Ds. In such a case, they may be able to support advanced technology based R&D by providing sufficient start-up funding to kick-start technology driven innovation.

2.19 There are limited opportunities for internships, collaborations, or guest lectures from industry professionals, which is very much needed in the STEM Courses. This leaves graduates with little understanding of the real-world demands and expectations of the corporate world, making it difficult to adapt and showcase their expertise effectively.

The problem statements in academic research should be synergized with the industry requirements. It is often observed that Industry

[11] https://files.eric.ed.gov/fulltext/ED502392.pdf

[12] https://files.eric.ed.gov/fulltext/ED502392.pdf

expectation for knowledge base for an R&D Engineer is far below the standard of academic research in India. This results into students opting for mediocratic R&D problems. Appropriate consortiums should be set up to generate compendium of problem statement from various industries to challenge the true potential of academics. This will certainly encourage students to opt for advanced R&D and the university level.

Q3. What measures should be taken pertaining to the tertiary institutions with a focus to encourage students towards advanced R&D at the university level?

A3. BIF Response

3.1 Collaborative research need to be encouraged to tackle complex challenges with diverse perspectives, with natural institutions to bridge theoretical research with real-world applications. Following steps can help to encourage students pertaining to the tertiary institutions with a focus to encourage students towards advanced R&D at the university level:

3.1.1 Focus on Applied Research and Innovation:

(i) Addressing real-world problems: Identify local and global challenges relevant to the region and prioritize research activities that directly contribute to solving them.

(ii) Encouraging entrepreneurial mindset: Cultivate a culture of innovation and commercialization by supporting student startups, spin-off companies, and technology transfer initiatives.

(iii) Integrating industry partners: Involve companies in research projects to ensure commercial viability and market relevance of developed solutions.

3.1.2 Cultivate Research Skills and Expertise:

(i) Enhance mentorship and training: Provide postgraduate research opportunities and mentorship programs to guide students in developing advanced research skills.

(ii) Invest in cutting-edge technology: Equip laboratories with advanced research equipment and software to ensure

students have access to the latest tools and methodologies.

(iii) Promote open access and knowledge sharing: Encourage publishing research findings in open-access journals and platforms to disseminate knowledge and foster collaboration with natural institutions.

By implementing these strategies, tertiary institutions can create a vibrant and impactful R&D landscape that surpasses traditional models and aligns with the unique challenges and opportunities facing natural institutions.

Science System

Q4. Whether current science system (network of public and private institutions involved in the production and consumption of R&D and innovation) is sufficient to foster R&D and innovation in India in general and ICT in particular?

If not, what additional measures are required to strengthen science system of the country and ensure availability of adequate resources for the same? Please support your answer with justification and best practices being followed in India and abroad in this regard.

A4. BIF Response

The Indian government has implemented various initiatives to bolster the science system. Despite these efforts, statistics and data show the outcomes haven't been encouraging. Further strengthening of the science system is crucial to foster R&D and innovation, especially in ICT.

4.1 As per OECD report-2022, producing slightly over 24,000 doctoral graduates, India is ranked fourth against the USA, which produces 68,000 graduates and tops the list. And as per Scopus, India ranks 6th in the number of papers published. And yet, the rank order in citations is at low 12th place, demonstrating the low research 'influence' we command. A key reason is the emphasis on quantity rather than utility/quality of the research. The commercial viability of the areas of research is a possible reason for low citations and low research 'influence' for India.

4.2 One may recall that the Science, Technology, Engineering and Mathematics (STEM) education in our schooling system was considered very strong. Globally it is well accepted that teaching of science and mathematics in Indian schools and Indian software skills are much stronger than in other countries. However, where we lack is that we are not that capable when it comes to Applications. When it was shifted from, science to applied science to engineering, there has been degradation in basic sciences. It should be more and more application oriented.

4.3 Indeed there are challenges inherent in India's current science system that limits its effectiveness in fostering R&D and innovation, particularly in the crucial field of ICT. To address these limitations, here are some key actions that can be taken:

4.3.1 Building a Collaborative Ecosystem:

(i) Break down silos: Encourage research collaborations across disciplines, from ICT interacting with fields like healthcare and agriculture to social sciences for ethical considerations.

(ii) Bridge the academia-industry gap: Facilitate joint research projects, knowledge exchange programs, and internships between institutions and private companies.

(iii) Strengthen public-private partnerships (PPPs): Leverage government funding and private sector expertise for strategic R&D initiatives in critical areas like AI, cybersecurity, and digital infrastructure.

4.3.2 Encouraging Talent Development and Retention:

(i) Revamp STEM education: Update curriculum and teaching methods to emphasize critical thinking, problem-solving, and collaboration alongside technical skills.

(ii) Invest in skill development programs: Provide targeted training in cutting-edge ICT technologies like AI, data science, and quantum computing, both for students and existing professionals.

(iii) Attract and retain top talent: Offer competitive salaries, research facilities, and career progression

opportunities to attract and retain researchers and technical experts within India.

4.3.3. Fostering Innovation and Commercialization:

(i) Create startup ecosystems: Establish incubation centers and accelerator programs to support early-stage ICT startups with infrastructure, funding, and mentorship.

(ii) Master's and PhD students opting for startup, after their graduation should be encouraged. They need to be financially supported by some extended fellowship program to enable their research into products. ICT technologies are mainly in deep-tech startup category and they take longer time to mature.

(iii) Simplify intellectual property (IP) processes: Streamline IP registration and protection to incentivize researchers and entrepreneurs to commercialize their innovations.

(iv) Connect with venture capital and angel investors: Create platforms and networks to help promising ICT startups secure funding and bridge the gap between research and market application.

Q5. How can the participation of public sector enterprises involved in R&D be augmented towards a synergized national effort in research, development, and innovation in ICT?

Please support your answer with justification and best practices being followed in India and abroad in this regard.

A5. BIF Response

5.1 Fostering the participation of public sector enterprises (PSE) in research, development, and innovation in Information and Communication Technology (ICT) involves learning from both domestic and international best practices. A few Public sector enterprises in India have heavily invested in R&D and have grown to Navaratnas in the past. The following actions could be considered by the PSEs in this regard:

(i) PSEs should be tasked to develop critical platform technologies of national priority / security in the respective sectors in time-bound manner.

(ii) A consortium of national research institutions & educational

institutions should be constituted to be the partners in this technology development program.

(iii) The government should share 50% investments (with balance 50% coming from PSEs) required for these technology development programs.

(iv) Research institutions will provide PhD students and the faculty with research bent of mind and the available research infrastructure.

Q6. What should be the prerequisites and key characteristics of an effective next-generation technology testbeds in India? Will defining national-level mission and strategic objectives for ICT help in their effective utilization?

Please support your answer with justification and best practices in India and abroad in this regard.

A6. BIF Response

6.1 Creating effective testbeds for emerging and next-generation technologies in India involves specific prerequisites and key characteristics. Given as below:

6.1.1 Infrastructure Readiness:

(i) Prerequisite: Ensure that the testbed has the necessary infrastructure to support the unique requirements of emerging technologies. This includes high-performance computing resources, advanced networking capabilities, Digital Twins and specialized equipment relevant to the technology being tested.

(ii) Key Characteristic: Develop a state-of-the-art infrastructure that aligns with the demands of diverse emerging technologies, such as Artificial Intelligence, Cloud Computing, Drones, Robotics, Blockchain, and Quantum Computing. This may involve collaborations with industry partners, research institutions, and government agencies to access cutting-edge hardware and software resources.

6.1.2 Real-World Application Integration:

(i) Prerequisite: To effectively test emerging technologies, it is

crucial to integrate real-world applications and use cases into the testbed. This requires a deep understanding of industry needs and challenges related to the specific technology under investigation.

(ii) Key Characteristic: Design the testbed to replicate real-world scenarios and challenges, allowing researchers and industry professionals to assess the performance and feasibility of emerging technologies in practical applications. Collaborate with industry stakeholders to identify relevant use cases and ensure that the testbed reflects the complexity of real-world deployment.

6.1.3 Collaborative Ecosystem**:**

(i) Prerequisite: Foster a collaborative ecosystem that brings together researchers, industry experts, startups, and government agencies. Collaboration is essential to gather diverse perspectives, share insights, and accelerate the development and adoption of emerging technologies.

(ii) Key Characteristic: Create mechanisms for open collaboration, knowledge sharing, and cross-disciplinary interaction. This could involve organizing workshops, conferences, and collaborative projects. Encourage the formation of innovation clusters or hubs where stakeholders can work together, leveraging each other's expertise and resources to drive advancements in emerging and next-generation technologies.

6.2 National-level Mission and Strategic Objectives Next-Generation Technology Test Beds in India

A national-level mission and strategic objectives for ICT shall create a framework that emphasizes the importance of technology development and adoption. Testbeds serve as practical tools within this framework, providing a controlled environment for experimentation, innovation, and collaboration. Examining best practices from countries like Singapore and South Korea demonstrates how strategic alignment and effective utilization of testbeds can contribute to the success of national ICT initiatives. Here are few

points to emphasize:

6.2.1 Alignment with National Development Goals:

(i) Justification: National missions often align with broader development goals, and ICT is a critical enabler in achieving these objectives. A national-level mission for ICT can outline strategic goals related to digital infrastructure, connectivity, and technology adoption. Testbeds then become instrumental in experimenting with and validating innovative ICT solutions that directly contribute to these goals.

(ii) Best Practices: In India, initiatives like the "Digital India" campaign have set ambitious goals for ICT development. Testbeds have been utilized to pilot and refine technologies that support these objectives of Digital India viz. digital inclusion, e-governance, and broadband access.

6.2.2 Innovation and Research Acceleration:

(i) Justification: National-level missions often emphasize innovation and research as key drivers of economic growth. A strategic objective for ICT can include the promotion of cutting-edge technologies. Testbeds provide a controlled environment for researchers, academia, and industry to collaborate, experiment, and validate novel ICT solutions before widespread deployment.

(ii) Best Practices: Internationally, countries like Singapore have established national-level programs like the "Smart Nation" initiative. Testbeds, such as the Living Lab initiative in Singapore, have played a crucial role in testing and refining smart city technologies, fostering innovation in areas like IoT, AI, and data analytics.

6.2.3 Industry Collaboration and Technology Adoption:

(i) Justification: National missions often seek to enhance the competitiveness of domestic industries through technology adoption. A strategic focus on ICT can encourage collaboration between the government, industry, and research institutions. Testbeds offer a platform for industry players to test and validate emerging technologies, facilitating

smoother adoption and integration into their operations.

(ii) Best Practices: In South Korea, the "5G Strategy" aims to establish the country as a leader in 5G technology. Testbeds like the 5G Open Testbed have been established to provide an environment for industry players to experiment with 5G applications, fostering innovation and accelerating the adoption of 5G technologies.

Q7. What role do you envisage for the service providers and industry in facilitating indigenous R&D in the ICT sector respectively?

How can industry participation in R&D in the ICT sector be further improved? Please support your answer with justification and best practices in India and abroad in this regard.

A7. BIF Response

7.1 A few major roles that telecom service providers and the industry can play in indigenous Research and Development (R&D) in ICT sector:

7.1.1 Investment in Advanced Technologies COEs & R&D Centers:

Telecom service providers can allocate significant resources to invest in the research and development of advanced technologies such as 5G, 5G and beyond, 6G, Artificial Intelligence, Machine Learning, IOT and Edge Computing. By actively participating in cutting-edge technology research, telecom providers can drive innovation by creating state-of-the-art infrastructure, bringing a competitive edge benefitting nation and to the overall industry.

7.1.2. Cybersecurity Innovation:

Given the increasing cyber threat canvass and the raising frequency and sophistication of cyber-attacks, telecom service providers can contribute significantly to indigenous R&D in cybersecurity. This includes the development of robust security protocols, threat detection and prevention mechanisms, secure broadband devices, creation of supply chain trust environments and post quantum Cryptography technologies. By actively participating in cybersecurity research, telecom providers can strengthen the resilience of digital networks.

7.1.3 Promoting Digital Inclusion:

Indigenous R&D initiatives can focus on developing solutions that promote digital inclusion. Telecom providers can help research and implement technologies that address connectivity challenges in underserved and remote areas. This may involve the development of affordable and accessible communication solutions to bridge the digital divide and ensure equitable access to ICT resources.

7.1.4 Collaboration with Startups and Innovation Ecosystems:

By actively engaging with emerging companies, startups, telecom providers can support through domain expertise and encourage the development of novel ICT solutions. Industry can also help innovators to carry Proof of Concept (POC) for validation and interoperability test of their solution/ products.

7.2 For better industry participation, key suggestions are made along-with justification and global best practices:

7.2.1 Public-Private Partnerships (PPPs):

Justification:

Collaborative efforts between the government, academia, and industry can create a conducive environment for R&D. PPPs facilitate the pooling of resources, expertise, and funding from multiple stakeholders.

Example:

In India, Govt. Policies like the National Digital Communications Policy (NDCP)-2018 have emphasized the importance of PPPs to accelerate the growth of the ICT sector. The government's collaboration with private players and research institutions helps leverage collective strengths.

7.2.2 Incentives and Funding Mechanisms:

Justification:

Providing financial incentives, tax breaks, and grants can motivate industries to invest in R&D activities. Access to funding encourages risk-taking and supports long-term research

projects.

Example:

The United States offers the Research and Development Tax Credit, providing tax incentives to companies engaged in qualifying R&D activities. Similarly, India has introduced schemes like the PLI and design-led PLI and the Modified Special Incentive Package Scheme (M-SIPS) to promote investments in the ICT sector. Close to approx. INR 25,000 Crores is being invested in the PLI schemes in the ICT Sector

7.2.3 Technology Clusters and Innovation Hubs:

Justification:

Establishing technology clusters and innovation hubs creates collaborative ecosystems where industry players can interact with startups, research institutions, and government bodies. This fosters knowledge exchange and accelerates innovation.

Example:

Silicon Valley in the United States is a prime example of a technology cluster that brings together leading tech companies, venture capital firms, and research institutions, fostering a culture of innovation and entrepreneurship.

7.2.4 Skill Development and Talent Acquisition:

Justification:

Industry participation in R&D is heavily dependent on the availability of skilled talent. Investing in education, training programs, and research-oriented curricula ensures a continuous pipeline of skilled professionals.

Example:

Germany's dual education system, combining theoretical learning with practical training within the industry, is credited with producing a highly skilled workforce. This approach ensures that graduates are equipped with the practical skills needed for R&D roles in the ICT sector.

Q8. How Telecom Centers of Excellence (TCOEs) can be made hubs of innovative product delivery to telecom industry?

What can be done to further strengthen the TCOEs in order to provide an impetus to innovations in the telecom sector?

Please support your answer with justification and best practices in India and abroad in this regard.

A8. BIF Response

8.1 Establishing Telecom Centers of Excellence (TCOEs) as hubs for innovative product delivery centers for the telecom industry in India requires a strategic approach. Here are a few key points to enhance the effectiveness of TCOEs in this regard:

8.1.1 Collaborative Ecosystems and Industry Partnerships:

i. Justification:

Foster collaboration between TCOEs, industry players, startups, and research institutions. Industry partnerships provide TCOEs with real-world challenges and opportunities for developing solutions for emerging technologies such as 5G, 6G, IoT, AI, Blockchain, Quantum communications, and edge computing that address the evolving needs of the telecom sector.

ii. Example:

TCOEs can establish partnerships with telecom service providers, equipment manufacturers, and startups to co-create and test innovative products. This collaborative approach has been successful in technology hubs globally, such as the Innovation Hubs in Silicon Valley.

8.1.2. Incubation and Acceleration Programs:

i. Justification:

Create incubation and acceleration programs within TCOEs to nurture startups and entrepreneurs. This allows for the rapid development and scaling of innovative products that can be seamlessly integrated into the telecom industry.

ii. Example:

TCOEs can provide startups with access to infrastructure,

mentorship, and funding. Programs like this have been successful in accelerators like Techstars and Y Combinator, fostering a culture of innovation and entrepreneurship.

8.1.3. Skill Development and Training Initiatives:

i. Justification:

Develop skill enhancement programs to ensure that TCOE personnel and associated industry professionals are well-versed in the latest technologies and industry trends. This fosters a talent pool capable of driving innovation.

ii. Example:

TCOEs can collaborate with educational institutions and industry bodies to design training programs that cover areas such as 5G technologies, network virtualization, and advanced analytics. This approach ensures that the workforce remains skilled and adaptable.

8.1.4. Technology Transfer and Commercialization Strategies:

i. Justification:

Establish mechanisms for technology transfer and commercialization of innovations developed within TCOEs. This involves creating pathways for industry adoption of successful products and solutions.

ii. Example:

TCOEs can work closely with industry associations and government bodies to facilitate the transfer of technologies developed in-house to the broader telecom industry. This can be achieved through licensing agreements, joint ventures, or spin-off companies.

8.2 Here are Key strategies to strengthen Telecom Centers of Excellence (TCOEs) and promote innovation in the telecom sector, supported by best practices from both abroad and India:

8.2.1. Industry Collaboration and Open Innovation:

i. Justification:

Foster strong collaborations between TCOEs and industry players. Encourage an open innovation model, where TCOEs actively engage with telecom companies, equipment manufacturers, and startups to

co-create solutions.

ii. Best Practice Abroad:

The Telecom Infra Project (TIP), initiated by Facebook, is an example of a global collaborative effort. TIP brings together industry leaders to work on innovative solutions for telecom infrastructure, promoting openness and collaboration.

iii. Best Practice in India:

The Centre of Excellence in Wireless Technology (CEWiT) in India collaborates with leading industry players, facilitating joint projects and research. This approach ensures that innovations are aligned with industry needs and challenges.

8.2.2 Support for Startups and Entrepreneurship:

i. Justification:

Establish incubation programs within TCOEs to nurture startups and entrepreneurs. Provide them with the necessary infrastructure, mentorship, and access to industry networks, enabling rapid development and commercialization of innovative solutions.

ii. Best Practice Abroad:

The Innovation Hub at Ericsson Garage supports startups and entrepreneurs in developing and testing new ideas. This initiative allows for the exploration of innovative concepts within a supportive ecosystem.

iii. Best Practice in India:

The TCOE for Machine-to-Machine (M2M) in Bengaluru, has a dedicated program to incubate startups focusing on IoT and M2M technologies. This initiative encourages entrepreneurship and accelerates the development of innovative products.

8.2.3 International Collaboration and Knowledge Exchange:

i. Justification:

Facilitate collaboration with international research institutions, fostering knowledge exchange and exposure to diverse perspectives. Joint research projects and partnerships with global entities can enhance the TCOE's research capabilities.

ii. Best Practice Abroad:

The collaboration between the European Telecommunications Standards Institute (ETSI) and various global organizations exemplifies successful international collaboration in telecom standards development, fostering innovation on a global scale.

iii. Best Practice in India:

The International Telecommunication Union Centre of Excellence (ITU CoE) in India collaborates with ITU and other international organizations to enhance knowledge and skills in the field of ICT. Such collaborations contribute to global best practices and standards.

8.2.4 Continuous Skill Development and Training:

i. Justification:

Invest in continuous skill development programs for researchers and professionals within TCOEs. This ensures that the workforce remains updated on the latest technologies and industry trends, promoting a culture of innovation.

ii. Best Practice Abroad:

The Fraunhofer Society in Germany emphasizes ongoing professional development for its researchers, allowing them to stay at the forefront of technological advancements.

iii. Best Practice in India:

The Telecom Sector Skill Council (TSSC) in India focuses on skill development programs to address the industry's needs. TCOEs can collaborate with organizations like TSSC to ensure a skilled and adaptable workforce.

8.2.5 Applied Research with Practical Relevance:

i. Justification:

Emphasize applied research that addresses practical challenges faced by the telecom industry. Ensure that the research outcomes have direct relevance and applicability, leading to the development of solutions that can be readily implemented.

ii. Best Practice Abroad:

The Telecommunications Software and Systems Group (TSSG) in Ireland is known for its applied research projects that have practical implications for the industry, ensuring a direct impact on innovation.

iii. Best Practice in India:

The Telecom Standards Development Society, India (TSDSI), focuses on applied research to develop standards that address the specific requirements of the Indian Telecom Industry. This ensures practical relevance and applicability of the research outcomes.

Q9. Is there a need to establish new Centres of Excellence for the broadcasting sector? What can be done to synergize telecom and broadcasting sectors for the objective of convergence?

Please support your answer with justification and best practices in India and abroad in this regard.

A9. BIF Response

9.1 Yes. There is a need to do so. Establishing Centers of Excellence (CoEs) for the broadcasting sector is crucial for contributing to the advancement and sustainability of the industry. Here are key points justifying the need for such centers:

9.1.1. Technological Innovation and Research:

The broadcasting sector is undergoing rapid technological changes, transitioning from traditional to digital platforms. CoEs offer a space for research and development, facilitating collaboration between stakeholders, researchers, and technology experts to address challenges in video compression, immersive media, content delivery, and signal processing.

9.1.2 Skill Development and Training:

The broadcasting industry requires a skilled workforce to navigate modern technologies. CoEs provide training programs and skill development initiatives to equip professionals with the knowledge needed for operation, management, and innovation. As technology evolves, professionals need to upskill and adapt to new tools and workflows. CoEs act as educational hubs, offering foundational and advanced training.

9.1.3. Industry Best Practices and Standards:

i. Setting Standards and Guidelines:

CoEs contribute to the establishment of industry best practices, standards, and guidelines. By conducting research and developing frameworks, these centers help create a cohesive and standardized approach to various aspects of broadcasting, including content production, distribution, and quality assurance.

ii. Ensuring Interoperability:

Standards developed by CoEs ensure interoperability and compatibility across different elements of the broadcasting ecosystem. This is crucial for fostering a cohesive and efficient broadcasting environment, where various technologies and equipment can seamlessly work together.

In summary, establishing Centers of Excellence for the broadcasting sector is essential for driving technological innovation, addressing industry-specific challenges, facilitating skill development, and setting standards that contribute to the overall growth and sustainability of the broadcasting industry.

Q10. What are the reasons behind MNCs primary focus on software rather than hardware in India? What measures can be taken to promote basic/applied research by MNCs strengthening the current R&D efforts in software and improving R&D efforts in hardware?

Suggest a suitable mechanism to establish a balanced R&D Science System in the country.

A10. BIF Response

10.1 MNCs have been a contributor to India's R&D landscape by imbibing R&D culture in Indian industry and by training Indian R&D professionals. There is a need to further involve and motivate MNCs in creating solutions for local needs as well as for the world. Confidence building measures includes the protection of IP, primarily Patents and Design to attract them in investing in Hardware development, with an aim to attract the foreign investments in R&D infrastructure and co-development of technologies in India.

10.2 Several factors contribute to the primary focus of MNCs on software

rather than hardware in India. Here are primary reasons along with challenges associated with the hardware sector in India:

10.2.1. Skilled Software Talent Pool:

i. Reason:

India has a large and skilled pool of software professionals and engineers. The country has been a significant contributor to the global IT services industry, with a strong emphasis on software development, programming, and emerging technologies.

ii. Cost-Effective Software Development:

The cost-effectiveness of software development in India compared to developed countries is a significant factor. MNCs can leverage the skilled workforce at a competitive cost, making it economically viable to focus on software-related activities.

iii. Challenge in Hardware:

In India the hardware industry faces challenges such as a shortage of skilled workers and the need for specialized expertise in areas like chip design and semiconductor manufacturing.

10.2.2. Outsourcing and Cost Efficiency:

iv. Reason:

MNCs often prioritize cost efficiency and outsourcing to remain competitive. India's software development capabilities, combined with cost-effective services, make it an attractive destination for outsourcing software-related activities.

v. Challenge in Hardware:

Hardware manufacturing, on the other hand, often requires significant investments in infrastructure and technology. The capital-intensive nature of hardware production can be a deterrent for MNCs, especially in a cost-sensitive global market.

10.2.3. Global Software Demand and Innovation:

Reason:

The global demand for software and IT services has been on the rise due to digital transformation, cloud computing, and advancements in technologies like artificial intelligence and machine learning. MNCs prioritize software to tap into this growing demand and stay at the forefront of innovation.

Challenge in Hardware:

The hardware industry faces challenges related to the pace of innovation and rapidly changing technology. Keeping up with advancements in hardware design and manufacturing requires significant investment, and MNCs may find it more convenient to engage with the fast-evolving software landscape.

10.3 Challenges in the Hardware Sector in India:

10.3.1 Infrastructure and Investment Requirements:

Hardware manufacturing and design require substantial investments in infrastructure, research and development, and technology. India faces challenges in providing the necessary infrastructure and financial incentives to attract large-scale hardware manufacturing investments.

10.3.2 Lack of Specialized Skills and Expertise:

The hardware industry demands specialized skills in areas such as chip design, semiconductor manufacturing, and hardware engineering. India, while making progress, still faces a shortage of professionals with expertise in these specialized domains.

10.3.3 Global Competition and Cost Pressures:

The hardware sector is highly competitive globally, with countries like China dominating manufacturing. Cost pressures and competition can make it challenging for India to establish itself as a significant player in hardware manufacturing without targeted policies and incentives.

Promoting basic and applied research by Multinational Corporations (MNCs) is crucial for advancing innovation, especially in the fields of software and hardware. Here are key measures that can be taken to strengthen current R&D efforts in software and improve R&D efforts in hardware:

Q11. What are the steps required to strengthen government-industry-academia linkages in the ICT sector on long terms basis? Please support your answer with justification and best practices in India and abroad in this regard.

A11. BIF Response

11.1 Here are key steps, along with justifications and best practices:

11.1.1 Establishing Collaborative Research Clusters:

i. Justification:

Establishing collaborative research clusters brings together government agencies, industry players, and academia to work on shared objectives. These clusters can focus on specific technological domains, fostering synergy and encouraging knowledge exchange.

ii. Best Practices Abroad:

The Fraunhofer Institutes in Germany serve as excellent examples. These institutes operate in collaboration with industry and academia, conducting applied research across various disciplines. The model emphasizes collaborative clusters, ensuring that research is aligned with industry needs and has practical applications.

iii. Best Practices in India:

The Indian Institutes of Technology (IITs) and the Indian Institutes of Information Technology (IIITs) are increasingly adopting cluster-based collaborative research models. Industry partnerships, joint research projects, and government-funded initiatives enhance collaborative efforts, creating a platform for sustained engagement.

11.1.2 Promoting Industry-Academia Collaboration through Innovation Hubs:

i. Justification:

Innovation hubs act as focal points for industry and academia collaboration. These hubs provide physical spaces for researchers,

industry professionals, and policymakers to interact, share ideas, and collaborate on projects that drive innovation.

ii. Best Practices Abroad:

Silicon Valley in the United States is a renowned innovation hub where industry giants, startups, and academia coexist. The proximity of leading universities and research institutions to major technology companies has led to a culture of continuous collaboration and knowledge transfer.

iii. Best Practices in India:

Bengaluru's Electronic City and Hyderabad's HITEC City serve as Indian examples of innovation hubs. These technology parks bring together IT companies, research institutions, and educational centers, fostering an environment where industry and academia collaborate on various fronts.

11.1.3. Developing Long-Term Industry-Academia Partnership Programs:

i. Justification:

Encouraging long-term partnership programs involves creating frameworks that enable sustained collaboration. These programs could include joint R&D initiatives, industry-sponsored research projects, and skill development programs tailored to industry needs.

ii. Best Practices Abroad:

The University-Industry Innovation Network (UIIN) in Europe promotes long-term partnerships between universities and industries. It facilitates collaborative projects, joint research initiatives, and knowledge transfer programs that contribute to sustained engagement.

iii. Best Practices in India:

The Ministry of Electronics and Information Technology (MeitY) in India has launched programs like the IMPRINT (Impacting Research Innovation and Technology) initiative. IMPRINT focuses on collaborative research between academia and industry to address societal challenges/ problems. Such initiatives lay the foundation for long-term partnerships and help in societal upliftment.

Regulatory Framework: Policies and Programs

Q12. Whether the current institutional mechanism is adequate to cater to the needs of R&D in ICT sector in India? Is there a need to create a separate agency to coordinate and look after R&D functions specifically in ICT sector?

If yes, suggest a suitable framework for the overarching agency. If not, how can synergy between stakeholders be established to ease out processes and monitor time bound R&D outcomes? Please support your answer with justification and best practices being followed in other sectors nationally or internationally.

A12. BIF Response

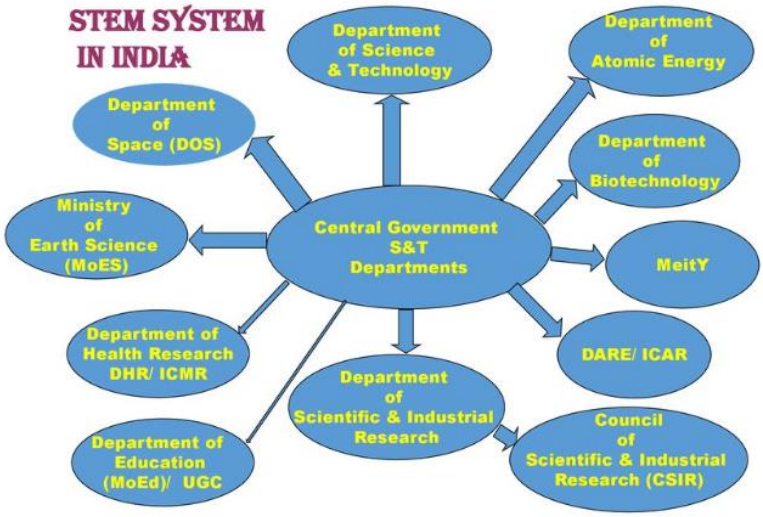
Institutional Mechanism for R&D in India:

India has a well-established Institutional Mechanism for R&D. The Ministry of Science and Technology's activities in India's R&D ecosystem are administered and managed via its three departments: DST, DBT and DSIR.

CSIR, an autonomous body under DSIR is India's leading publicly funded R&D organization that promotes advance knowledge in natural sciences and engineering, and translates it for the benefit of the people. The CSIR directs its research and development towards the goal of prosperity and well-being of the people. CSIR accomplishes this by:

- Technology development and innovation
- S&T services for the Industry
- Exploratory research and advanced research training
- Setting-up and operating national resource centers, facilities, collections and databases

The Science and Engineering Research Board (SERB) provides financial and monitoring support for research projects and facilities, with funding categories including awards, fellowships, schemes, and partnership programs.



The Department of Science & Technology plays a pivotal role in promotion of science & technology in the country.

12.1. Regulatory Framework:

i. Assessment:

The regulatory framework for ICT R&D in India has shown improvement in recent years. Initiatives such as the National Digital Communications Policy (NDCP) and policies from the Ministry of Electronics and Information Technology (MeitY) have aimed to create an enabling environment for innovation. The framework includes provisions for intellectual property rights, data protection, and cybersecurity, addressing key aspects of ICT R&D.

ii. Challenges:

Challenges still persist in terms of agility and responsiveness to rapidly evolving technologies. Ensuring that regulations stay abreast of emerging trends such as AI, Blockchain, Quantum Communications, PM-WANI Stacks and Cyber Security are essential. Additionally, the regulatory landscape may need continuous refinement to balance innovation with ethical considerations, privacy concerns, and security requirements.

12.2. Government Funding and Incentives:

i. Assessment:

The government has introduced various funding and incentive

programs to support ICT R&D in India. Organizations like the Department of Science and Technology (DST), MeitY, and the Ministry of Communications provide grants, subsidies, and incentives for research initiatives. Schemes like the Electronics Development Fund (EDF) and Startup India have aimed to foster innovation and entrepreneurship in the ICT sector.

ii. Challenges:

While these initiatives signal government commitment, challenges may include ensuring equitable distribution of funds, reducing bureaucratic hurdles, and maintaining a balance between supporting established institutions and promoting startups and grassroots innovation.

Q13. What steps must be taken to ensure a transparent mechanism for adequate and timely disbursement of funds for R&D programs? What should be indicators for the tracking mechanism for the funds and outcomes of R&D programs?

Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A13. BIF Response

13.1 Ensuring a transparent mechanism for adequate and timely disbursement of funds for Research and Development (R&D) programs is crucial for fostering innovation and sustained progress. Here are the key steps that can be taken to achieve transparency in fund disbursement for R&D programs:

13.1.1 Standardized Application and Evaluation Processes:

i. Design Transparent Application Procedures:

Establish standardized procedures for submitting funding applications. Provide detailed guidelines outlining eligibility criteria, required documentation, and evaluation parameters. This clarity ensures that applicants understand the process and can prepare comprehensive proposals.

ii. Implement Fair and Transparent Evaluation Criteria:

Define objective and measurable criteria for evaluating R&D

proposals. This may include factors such as research significance, methodology, feasibility, and potential impact. Establish an evaluation committee with diverse expertise and ensure transparency in the evaluation process, including disclosure of evaluators' conflicts of interest.

iii. Regularly Update Guidelines:

Periodically review and update the application and evaluation guidelines to align with changing research priorities, industry needs, and global advancements. Transparent communication about updates and changes is essential to maintain trust in the funding process.

13.1.2 Monitoring and Reporting Mechanisms:

i. Implement Robust Monitoring Systems:

Establish a monitoring mechanism to track the progress of funded R&D projects. This includes regular updates from grantees, milestones achieved, and any deviations from the proposed timeline or budget. Use technology-driven solutions to automate reporting processes and ensure real-time visibility into project outcomes.

ii. Open Communication Channels:

Foster open communication between funding agencies and research institutions. Create platforms for grantees to share their progress, challenges, and success stories. Regular meetings, webinars, and forums can facilitate dialogue, allowing funders to address concerns promptly and adjust support based on evolving project needs.

iii. Publish Outcome Reports:

Develop a practice of publishing outcome reports summarizing the achievements and impact of funded R&D projects. Sharing success stories and lessons learned enhances transparency, builds accountability, and demonstrates the tangible outcomes of the funding programs to stakeholders and the public.

13.1.3 Establishment of Oversight and Accountability Mechanisms:

i. Independent Oversight Committees:

Form independent oversight committees or review boards responsible for monitoring fund disbursement, ensuring adherence to guidelines,

and evaluating the impact of R&D programs. Independence from the funding agency ensures impartiality and strengthens the credibility of the oversight process.

ii. *Audits and Financial Transparency:*

Conduct periodic audits of R&D programs to ensure financial transparency and compliance with established guidelines. Make audit reports publicly available to demonstrate accountability. Implement financial controls, and establish mechanisms for addressing instances of financial mismanagement or non-compliance.

iii. *Incorporate Stakeholder Feedback:*

Seek feedback from various stakeholders, including researchers, industry representatives, and the public. Establish feedback mechanisms to gather insights on the effectiveness of the fund disbursement process, identify areas for improvement, and address concerns raised by stakeholders.

Here are key steps with suitable examples or frameworks and best practices from India and abroad:

13.2 Implementing Clear Application and Evaluation Processes:

i. *Example:*

National Science Foundation (NSF) in the United States

ii. *Design Transparent Application Procedures:*

Implement a clear and standardized application process. The NSF provides comprehensive guidelines for proposal preparation, ensuring that researchers understand the criteria and requirements.

iii. *Fair and Transparent Evaluation Criteria:*

Define objective and measurable criteria for proposal evaluation. NSF employs a merit review process with established criteria such as intellectual merit and broader impacts, ensuring fairness and transparency in project selection.

iv. *Regularly Update Guidelines:*

Periodically review and update application guidelines to stay aligned with evolving priorities. The Wellcome Trust in the UK regularly revises

its grant application guidelines to reflect changes in research priorities and methodologies.

13.3 Utilizing Technology for Monitoring and Reporting:

i. *Example:*

European Research Council (ERC)

ii. *Implement Robust Monitoring Systems:*

Utilize technology to create efficient monitoring systems. ERC uses an online platform for project reporting, allowing grantees to submit updates and milestones seamlessly.

iii. *Open Communication Channels:*

Foster open communication through regular webinars and forums. ERC organizes events such as the ERC Days, bringing together grantees to share insights and progress updates.

iv. *Publish Outcome Reports:*

Promote transparency by publishing outcome reports. The Indian Council of Medical Research (ICMR) in India regularly publishes reports summarizing the outcomes and impact of funded medical research projects.

13.4 Establishment of Oversight and Accountability Mechanisms:

i. *Example:*

Australian Research Council (ARC)

ii. *Independent Oversight Committees:*

Form independent committees for oversight. ARC has the College of Experts, comprising eminent researchers, industry experts, and community leaders, to provide independent advice and oversight.

iii. *Audits and Financial Transparency:*

Conduct regular audits to ensure financial transparency. The Canada Foundation for Innovation (CFI) undergoes periodic audits, and audit reports are made publicly available to ensure accountability.

iv. *Incorporate Stakeholder Feedback:*

Seek feedback from stakeholders. The Swedish Research Council involves

external experts and international peers in the review process, incorporating diverse perspectives.

Q14. How can participation of private sector in R&D be encouraged? Which Incentivization model(s) or combination thereof would produce better results?

a) Tax-break model, or
b) Product-Linked Incentivization model
c) Any other model.

Please provide details of the suggested model(s) in terms of structure, functioning, monitoring, and evaluation.

A14. BIF Response

14.1 To create global technology leaders, Governments in many countries provide special incentives to domestic companies, private sector who are seriously investing in R&D and product development[13].

14.2 Many countries have already enacted regimes like patent box to spur innovation and create domestic manufacturing jobs. Among the countries that have patent box regimes are China, Belgium, the United Kingdom, France, the Netherlands, Italy, and Belgium[14]. A "patent box" is a term for the application of a lower corporate tax rate to the income derived from the ownership of patents. This tax subsidy instrument has been introduced in several countries since 2000[15].

14.3 Encouraging the participation of the private sector in R&D involves deploying effective incentivization models. Different models, such as tax-break models, product-linked incentivization models, and others, can be employed to stimulate R&D activities. The optimal approach often involves a combination of models tailored to the specific context.

Here are key points highlighting various incentivization models:

14.4. Tax-Break Model:

a) Accelerated Depreciation and Expense Deductions:

i. Model Description:

[13] https://www2.deloitte.com/lu/en/pages/tax/solutions/research-development-government-incentives-overview.html
[14] https://ipwatchdog.com/2015/09/13/the-advantages-of-enacting-a-patent-box-regime/id=61571/
[15] https://www.nber.org/system/files/working_papers/w24843/w24843.pdf

Offer tax incentives through accelerated depreciation or increased expense deductions for R&D-related investments. This allows companies to recover their R&D costs more quickly, providing a financial boost.

ii. Example:

The Modified Accelerated Cost Recovery System (MACRS) in the United States accelerates the depreciation of certain R&D assets, enabling companies to realize tax benefits sooner.

b) R&D Tax Credits:

i. *Model Description:*

Introduce tax credits specifically for R&D expenditures. These credits reduce a company's tax liability based on a percentage of eligible R&D expenses, directly incentivizing investment in research activities.

ii. *Example:*

The Research and Development Tax Credit in the United States provides a tax credit for a portion of qualified R&D expenses, encouraging ongoing investment in innovation.

14.5 Product-Linked Incentivization Model:

a) Market Exclusivity and Regulatory Incentives:

i. *Model Description:*

Provide companies with market exclusivity or regulatory incentives for a defined period for products resulting from R&D efforts. This model ensures a competitive advantage and encourages companies to invest in R&D by securing a favorable position in the market.

ii. *Example:*

Orphan Drug Act in the United States grants market exclusivity to pharmaceutical companies developing drugs for rare diseases, fostering R&D in this niche.

14.6 Advanced Market Commitments (AMCs):

i. *Model Description:*

Governments commit to purchasing a certain quantity of a new

product at a predetermined price, reducing the financial risks associated with bringing innovative products to market and providing assurance to companies investing in R&D.

ii. *Example:*

Pneumococcal AMC is a global initiative that guarantees a market for pneumococcal vaccines, incentivizing pharmaceutical companies to invest in the development of vaccines for diseases prevalent in developing countries.

14.7 Other Incentivization Models:

a) Public-Private Partnerships (PPPs):

i. Model Description:

Facilitate collaborations between the public and private sectors in R&D initiatives. Governments provide funding, expertise, and infrastructure, while private companies contribute resources, technology, and market-driven insights.

ii. Example:

European Technology Platforms (ETPs) bring together public and private stakeholders to define research priorities and strategies for specific sectors, fostering collaboration and knowledge exchange.

b) Matching Grants and Challenge Funds:

i. Model Description:

Provide matching grants or challenge funds where the government matches private sector investments in R&D. This approach amplifies the impact of private sector contributions.

ii. Example:

The Grand Challenges program by the Bill & Melinda Gates Foundation offers challenge grants to encourage private sector innovation in addressing global health and development challenges.

c) Innovation Clusters and Ecosystem Support:

i. Model Description:

Develop innovation clusters and ecosystems that bring together

companies, research institutions, and startups. Creating a conducive environment fosters collaboration, knowledge sharing, and access to talent.

ii. Example:

Silicon Valley in the United States is a renowned innovation cluster that emerged through the organic growth of technology companies, venture capital, and research institutions, creating a dynamic ecosystem.

d) Optimal Approach:

The effectiveness of Incentivization models depends on the industry, economic context, and the specific goals of the government. A combination of models, rather than relying on a single approach, often produces better results. For instance, a country might combine tax incentives with market exclusivity for certain sectors while fostering public-private partnerships for broader industry collaboration. This diversified approach allows for a more comprehensive and adaptable strategy to stimulate private sector participation in R&D. The key is to tailor the Incentivization mix to the unique characteristics and needs of the industry and economy.

Q15. Is there a need for a mechanism to promote research, development, and innovation at the state level? Will a ranking mechanism for the states help to promote the spirit of innovation? If yes, please comment on the structure of such a mechanism with key performance indicators.

A15. BIF Response

15.1 Yes-there is a need for mechanism to promote R & D innovation at state level which mirrors the Central Model. There appears to be no shortage of funding for centrally-funded 'top tier' institutions, such as the IITs, IIMs, and Institutes of National Importance. However, research budgets often remain underspent due to a lack of good quality research proposals so here international collaboration can help through professional networking and specific skills such as proposal writing[16].

15.2 Centrally funded institutions contribute to more than sixty percent of

[16] https://www.britishcouncil.org/sites/default/files/understanding_india_report.pdf

the research publications. Centrally funded institutions have increased from 62.46% in 2001-2006 to 72.7% in 2016-2020. Almost all major institutions have recorded growth in their research output volume during the period.

15.3 Institutions under the state governments constitute a large share and an improvement in the research culture in those institutions will result in a manifold increase in India's research output. It is equally important that government and private stakeholders work together in a collaborative and complementary manner to ensure holistic growth in the R&D capabilities of Indian institutions[17].

15.4 India is characterized by a diverse socio-economic and cultural landscape, with each state having its unique challenges and opportunities. A state-level mechanism for promoting ICT research and innovation allows for customization and contextualization of solutions to address specific regional needs. For example, states with predominantly agrarian economies may focus on ICT solutions for precision agriculture, while urbanized states may prioritize smart city technologies.

15.5 Many ICT solutions require localization to effectively serve the linguistic and cultural diversity within India. State-level initiatives can facilitate the development of technology solutions that are linguistically and culturally relevant, leading to higher adoption rates and increased impact. Customized applications, content, and services can better resonate with the local population, promoting inclusivity and accessibility.

15.6 States face distinct challenges, such as infrastructure disparities, educational variations, and diverse economic structures. A state-centric approach allows for targeted R&D efforts to address these challenges. For instance, in states with limited access to healthcare, ICT innovations can be tailored to improve telemedicine, health information systems, and healthcare delivery.

15.7 The ranking mechanism encourages states to invest in and support innovation through targeted programs, focusing on outcomes like patent filings and startup success. It also assesses the state's efforts in

[17] https://www.currentscience.ac.in/Volumes/123/09/1082.pdf

promoting education and skill development in STEM disciplines. The comprehensive innovation index assesses various dimensions of innovation, including technology adoption, research and development, entrepreneurial ecosystem, and government policies supporting innovation. Key performance indicators include research and development expenditure, startup density, technology adoption rate, and innovation support programs.

Regulatory Framework: IPR Framework

Q16. How can awareness about IPR be increased among the researchers and industry in ICT sector?

Suggest action points for making IPR as a part of syllabus in graduation /post-graduation level in colleges. Please support your answer with justification and best practices in India and abroad in this regard.

A16. BIF Response

16.1 Most of India's startups are in the IT/ knowledge-based sector. Intellectual property, specifically patents are key to this knowledge-based economy. As per Economic Survey 2022[18], the number of patents granted in India is still a fraction compared to patents granted in China, USA, Japan, and Korea. According to World Intellectual Property Organization (WIPO), the number of patents granted in China, USA, Japan, Korea stood at 5.30 lakh, 3.52 lakh, 1.79 lakh, 1.35 lakh, respectively for 2020. Meanwhile in India the patents granted has gone up from 7,509 in 2010-11 to 9,847 in 2016-17 to 28,391 in 2020-21. Which is still a little contribution to global IP pool.

16.2 The survey reveals that India's low patents are largely due to its low expenditure on Research and Development (R&D), which accounted for 0.7% of its GDP in 2020. This low R&D expenditure, coupled with procedural delays, exposes India's underdeveloped STEM research ecosystem. The government-funded R&D expenditure heavily outweighs private expenditure, highlighting India's unique situation.

16.3 India's intellectual property rights (IPR) are less valuable than in other countries due to historical low importance and societal reluctance to

[18] https://www.indiabudget.gov.in/economicsurvey/ebook_es2022/files/basic-html/page365.html

monetize knowledge. Standard Essential Patents (SEPs) are crucial in India's telecommunications and technology sector, promoting innovation, connectivity, and foreign investments. Challenges include balancing rights protection with affordable access, determining reasonable royalty rates, and legal battles over FRAND licensing terms. Modern enforcement approaches and initiatives like the Arctic Invent SEP dashboard help maintain technological independence, market access, job creation, and global recognition.

16.4 Patents and standards serve common objectives of encouraging innovation and diffusion of technology. Standard organizations, require members to disclose and grant licenses to their patents and pending patent applications that cover a standard that the organization is developing. If a standard organization fails to get licenses for all patents that are essential to comply with a standard, owners of the unlicensed patents may demand or sue for royalties from companies that adopt the standard.[19]

16.5 The Indian government could help startups overcome funding barriers by investing in patent filing and winning, as small startups often opt for unitary patents in Europe. This could be achieved through the Telecom Technology Development Fund (TTDF) or the Digital Bharat Nidhi created through the Telecommunications Act 2023. Additionally, the government could offer financial discounts to startups, MSMEs, and online application applicants, aiming to meet the Union Minister's goal of 10% of 6G patents from India.

16.6 Increasing awareness of Intellectual Property Rights (IPR) among researchers and industry professionals in the Information and Communication Technology (ICT) sector is crucial for fostering innovation, protecting intellectual assets, and promoting responsible use of technology. Integrating IPR education into the curriculum at the graduation and post-graduation levels in colleges can play a pivotal role.

16.7 Here are few action points with justifications and examples from India and abroad:

[19] http://www.ipindia.nic.in/writereaddata/Portal/News/196_1_standard EssentialPaper_01March2016_1_.pdf

a) Engage experts and professionals: Invite experts and IPR professionals to guest lecture at colleges and share practical insights.

b) Encourage industry professionals to mentor students and promote IPR awareness. Collaboration with industry experts ensures practical relevance and industry-specific insights.

c) Provide resources: Develop and distribute IPR-related educational materials, including guides, videos, and e-learning resources. Establish online platforms for easy access to IPR information and updates

d) The National University of Singapore (NUS) is a successful collaboration between educational institutions and industry experts in intellectual property rights (IPR). Through workshops, seminars, and guest lectures, the university provides students with both academic and practical insights, making IPR education more relevant and applicable in the real world.

e) Capstone projects and case studies on intellectual property (IPR) can effectively teach students about IPR issues in ICT projects, enhancing their critical thinking and problem-solving skills. The University of Oxford's "Intellectual Property and Information Technology" course incorporates practical exercises, case studies, and group projects. Colleges should invite guest lecturers, encourage industry professionals to mentor students, provide resources, and establish online platforms for easy access to IPR information.

Q17. What essential steps can be taken to further improve the speed and efficiency of the patent approval process for ICT in India?

Please support your answer with justification and best practices in India and abroad in this regard.

A17. BIF Response

17.1 The average pendency for final decision in acquiring patents in India is 42 months as of 2020[20]. This is much higher than 20.8, 20, 15.8 and 15 months respectively for USA, China, Korea and Japan. The average pendency for final decision in acquiring patents has reduced in India from 64 months in 2017 to 52 months in 2019 and further to 42 months

[20] https://www.niti.gov.in/sites/default/files/2022-07/India-Innovation-Index-2021-Web-Version_21_7_22.pdf

in 2020," according to the Economic Survey.

17.2 Improving the speed and efficiency of the patent approval process for Information and Communication Technology (ICT) in India is crucial for fostering innovation and ensuring timely protection of intellectual property.

17.3 Here are major steps with justification and examples from India and abroad, that can be taken to further improve the speed and efficiency of the patent approval process for ICT in India:

a) Implementation of Patent Prosecution Highway (PPH)[21]:

A Patent Prosecution Highway (PPH) program for ICT patent applications can expedite examinations by utilizing results from foreign offices, reducing duplication and accelerating the overall process. Implementing a similar program in India could improve efficiency for ICT patent applications

b) Enhanced Use of Technology and Data Analytics[22]:

The European Patent Office (EPO) is implementing advanced technology and data analytics tools to automate patent examination processes, improving accuracy and decision-making. This approach, which uses machine learning and artificial intelligence for semantic searching and classification, can enhance efficiency in ICT patent examination.

c) Introduction of Expedited Examination Programs:

Promoting expedited examination programs for ICT patent applications can help applicants with time-sensitive innovations or those willing to pay an additional fee expedite the process, ensuring faster turnaround. This not only caters to the dynamic nature of the ICT sector but also generates additional revenue for the patent office. Best practices, such as the United States' Track One prioritized examination, can be tailored for the ICT sector in India.

d) Transparency and Stakeholder Engagement:

Promoting expedited examination programs for ICT patent applications can expedite the approval process for time-sensitive

[21] https://ipindia.gov.in/newsdetail.htm?593
[22] https://www.iam-media.com/article/crunching-the-numbers-how-patent-analytics-can-help-ip-owners-get-ahead

innovations and those willing to pay an additional fee, generating additional revenue for the patent office and catering to the dynamic nature of the ICT sector.

e) Capacity Building and Specialized Training:

The European Patent Office (EPO) is enhancing patent examination efficiency by investing in capacity building for examiners, especially in the ICT sector, through specialized training programs to assess emerging technologies like AI, Blockchain, and Cybersecurity.

17.4 The following steps are recommended to be taken:

- Prioritize ICT-related patents: Given the rapid advancements in ICT, prioritizing the examination of these patents can stimulate innovation and economic growth.
- Collaborate with industry and experts: Collaborating with industry stakeholders and experts can lead to better understanding of ICT inventions, resulting in quicker and more informed decisions esp. in the areas of 5G, 6G, AI and Blockchain.

  Establish a dedicated ICT patent examination division**:** Creating a specialized division focused on ICT patents can lead to more efficient

Q18. Is there a need to reduce the cost of filing patents in India?

If yes, how can it be done? Please support your answer with justification and best practices in India and abroad in this regard.

A18. BIF Response

18.1 Yes, there is a need to subsidize the cost of filing patents (outside India) for domestic companies. Subsidizing the cost of patent filing outside India will encourage innovation, particularly domestic companies and allow them to develop patent portfolio that can compete with the global competition.

18.2 For startups filing patents in India costs approximately INR 15,000 to 30,000 and total cost of granting and maintaining patents is approximately INR 40,000 to 50,000 for 20 years. Affordable patent filing can motivate entrepreneurs and small businesses to invest in research and development, driving technological advancements.

The price of a patent application from start to finish in foreign countries

ranges from a few hundred dollars to 100,000 dollars depending on nature of patent.

18.3 Many countries worldwide have implemented measures to reduce the cost of patent filing, aligning with global trends in making intellectual property protection more accessible.

18.4 Lowering the cost of filing patents can encourage more innovators, including startups and individuals, to protect their inventions, which can foster innovation and economic growth. Further, reduced costs make the patent system more inclusive, allowing a wider range of inventors to participate and benefit from intellectual property protection. Moreover, lower filing costs can make India more competitive in attracting foreign investment and research and development (R&D) activities, which can contribute to technological advancement.

18.5 Reducing the cost of filing patents in India is a strategic move that can have positive effects on innovation, economic development, and the overall competitiveness of the nation.

Here are three justifications for lowering the cost of filing patents, with references to practices in India and abroad:

a) Fostering Innovation Ecosystem:

Lowering patent filing costs in India could foster a more inclusive innovation ecosystem, as high costs can deter SMEs, startups, and individual inventors from protecting and commercializing their inventions. This aligns with the government's initiatives to support startups and promote innovation, such as the Startup India initiative. Countries like China have also implemented policies to reduce filing fees for certain applicants, contributing to the rapid growth of patent applications.

b) Enhancing Technology Transfer

Lowering patent filing costs encourages technology transfer and collaboration between academia, research institutions, and industries. This encourages researchers and inventors to share their knowledge, leading to increased collaboration and commercialization of research outcomes. Countries like India and Germany have implemented measures to support technology transfer and collaboration, with lower

filing costs contributing to a collaborative environment where research institutions actively engage with industries to translate research into commercially viable products.

c) Boosting Global Competitiveness:

The cost of patent filing in India need to be reduced to boost the country's global competitiveness. This move aligns with the "Make in India" initiative, making India an attractive destination for global businesses and inventors. Countries like South Korea have also implemented fee reduction programs for international patent applications, enhancing their competitiveness in the global intellectual property landscape. This strategic move promotes a more inclusive innovation ecosystem, encourages collaboration, and enhances India's global competitiveness in the field of intellectual property.

Q19. As far as the ICT sector is concerned, suggest measures to enhance filing of patents in India in general and by resident Indians in particular. Do we need a mechanism for handholding in patent filing? Do we need a mechanism of IPR sharing for collaborative research projects?

Please support your answer with justification and best practices in India and abroad in this regard.

A19. BIF Response

19.1 YES –we need a mechanism for handholding in patent filing and for collaborative research

19.2 India should encourage more resident Indians to file patents, making them a mortgage able asset like physical property with due valuation. This would allow industries or start-ups to mortgage IP assets to banks for funding or working capital. Tax incentives on sales proceeds for products with embedded IP could also encourage filing.

19.3 Enhancing the filing of patents in India is crucial for fostering innovation, economic growth, and strengthening the country's intellectual property ecosystem. Here are key measures that can be implemented to encourage and facilitate increased patent filings in India:

a) Streamline Patent Application Processes:

The Indian government should streamline the patent application

process by making it more user-friendly, providing clear guidelines, and utilizing technology to create an efficient online filing system. This will reduce barriers for inventors and businesses, attracting a wider range of applicants, including startups, SMEs, and individuals with limited resources. Similar initiatives have been implemented by the USPTO.

b) Provide Financial Incentives and Support:

The proposal proposes financial incentives and support mechanisms for startups, SMEs, and educational institutions, along with exploring government grants or subsidies, to make patent filing more accessible and encourage a wider range of innovators to protect their intellectual property. China, for instance, has implemented such incentives, contributing to its global leadership in patent filings, particularly in technology and innovation.

Q20. (a) Is the Fair, Reasonable, and Non-Discriminatory (FRAND) mechanism for licensing of Standard Essential Patents (SEPs) functioning satisfactorily and effectively? Is there a need for any reforms in this aspect?

(b) How can small innovators be protected from the predatory practices?

Please support your answers with justification and best practices in India and abroad in this regard.

A20. BIF Response

20.1 The FRAND mechanism is by and large functioning satisfactorily. However, there needs to be a universal acceptance and recognition of the role played by SEPs and their importance in reduction of costs in the overall product ecosystem, particularly amongst domestic Indian companies.

20.2 Due to lack of respect of SEPs based on the FRAND principle, Indian domestic companies took a long time to reach the end of the production curve and achieve economies of scale, thereby leading to inability of the domestic companies to match the scale of production of global majors and thereby inability to match the global pricing and capture a significant market share

20.3 A globally accepted mechanism exists in the licensing field in India and abroad for obtaining licenses on standardized technologies. The mechanism involves good-faith discussions between the SEP holder and implementer, based on CJEU's guidelines. If no agreement is reached, parties can resolve issues through ADR mechanisms or a Court of Law, leading to a FRAND license. If the terms are unacceptable, the SEP holder can seek an injunction. This approach has been supported by the Delhi High Court in two SEP disputes.

20.4 India has established efficient mechanisms for handling Subvention and Protection of Designs (SEP) issues, with courts providing speedy remedies through newly constituted IP Divisions. The Patents Act protects small innovators from predatory practices, ensuring Indian courts are competent to understand and provide relief. The Indian patent system should encourage domestic innovators to participate in global standardization, as patent litigation is difficult, time-consuming, and expensive. India may consider adopting similar mechanisms to the US International Trade Commission, which can stop importation of products infringing on US patents.

20.5 Analyzing the functionality of the Fair, Reasonable, and Non-Discriminatory (FRAND) mechanism for licensing Standard Essential Patents (SEPs) requires a comprehensive assessment of its impact on innovation, competition, and industry dynamics. Here are key points:

a. Balancing Innovation and Competition:

The FRAND mechanism balances innovation and competition by compensating SEP holders for their contributions to essential standards. It prevents market power abuse through fair, reasonable, and non-discriminatory licensing terms. For wireless communication standards like 4G and 5G, FRAND commitments have been crucial in implementing these standards without unfair or discriminatory terms, fostering a competitive environment and encouraging innovation.

b. Avoiding Anti-Competitive Behavior:

The FRAND mechanism safeguards competition by preventing dominant SEP holders from stifling competition. It establishes a licensing framework that prevents discriminatory practices and ensures fair access to essential technologies. The European Union has actively

promoted the enforcement of FRAND commitments, involving antitrust investigations and legal actions against companies allegedly violating FRAND principles, reinforcing the importance of fair and non-discriminatory licensing.

c. Facilitating Cross-Industry Collaboration:

The FRAND mechanism promotes interoperability by encouraging the development and adoption of standardized technologies across industries. This facilitates seamless integration of products and services across sectors, such as in the development of IoT standards. The collaborative nature of standardization efforts enhances the overall ecosystem for IoT applications.

d. Resolving Disputes through Negotiation:

The FRAND mechanism allows for negotiation-based dispute resolution in licensing negotiations, reducing legal battles and promoting quicker problem-solving. An example is the Qualcomm and Apple settlement, which involved a global patent licensing agreement after years of legal battles over FRAND-related issues, showcasing the potential of negotiation in resolving disputes amicably

In summary, reforms should focus on making the FRAND terms more transparent and standardized, enabling equitable access to SEPs, especially in emerging technology areas. The European Telecommunications Standards Institute (ETSI) is continuously refining its guidelines for FRAND licensing, serving as a valuable model for adaptability. Strengthening legal mechanisms, such as antitrust and patent misuse laws, can be a shield from exploitation.

Q21. (a) What additional measures should be taken to strengthen IPR dispute resolution mechanism to ensure confidentiality of the innovation and time-bound disposal of IPR-related disputes?

(b) How can Alternate Dispute Resolution (ADR) mechanisms for IPR disputes be improved? Please support your answer with justification and best practices in India and abroad in this regard.

A21. BIF Response

(a) Strengthening the Intellectual Property Rights (IPR) dispute resolution mechanism to ensure confidentiality of innovation and time-bound disposal

of IPR-related disputes is crucial for fostering a fair and efficient legal framework. However, this should be based on a general acceptance of the SEPs based on FRAND framework.

It is our ability to produce more SEPs as a nation that will help create equitable balance while promoting next generation standards and technologies viz. 6G.

Once SEPs are respected through the entire ecosystem, the number of disputes related to IPRs would automatically come down, leading to less stress and emphasis on dispute resolution frameworks and mechanisms.

21.1 Section 89 of the Code of Civil Procedure, 1908 states that "if the court deems fit, it can allow arbitration, mediation or conciliation for settlement of disputes between parties outside the court." Arbitration as a mode of alternative dispute resolution is an efficient and effective means to resolve disputes, especially commercial disputes. However, the arbitrability of some disputes due to their subject matter is questionable and in fact, it may even be argued that certain matters are incapable of resolution via arbitration and therefore, litigation may be the only remedy available for them.

21.2 Intellectual property ("IP") law is a rapidly evolving in India and there is a growing need for efficacious adjudication of disputes arising out of such rights. Since no statutory provision clearly lists disputes or subject matters which are or are not arbitrable, judicial interpretation on the matter is widely relied upon. The ambiguity around this issue has been the result of confusing interpretations, lack of a set precedent, as well as differing opinions by different Indian High Courts.

21.3 Indian courts are well-equipped to handle intellectual property (IPR) disputes, as evidenced by the Delhi High Court's annual report. They are adept at resolving complex issues while keeping abreast of global developments. This has led to the formation of IP Divisions by more High Courts, establishing a robust dispute resolution mechanism within India's borders.

21.4 Here are few additional measures that can be taken for strengthening the Intellectual Property Rights (IPR) dispute resolution mechanism:

i. <u>Establish Specialized IPR Courts or Tribunals:</u>

Specialized intellectual property (IPR) courts can expedite the resolution process by providing judges with a deeper understanding of intellectual property issues. These courts can prioritize IPR cases, ensuring timely disposal. The USITC, a federal agency, adjudicates cases related to unfair practices in import trade, demonstrating the benefits of such specialized courts.

ii. Mandatory Mediation or Alternative Dispute Resolution (ADR) Processes:

Mandatory mediation or arbitration processes before litigation can expedite dispute resolution while maintaining confidentiality. Mediation allows parties to discuss and negotiate a resolution with a neutral third party, encouraging cooperative and swift resolution. The World Intellectual Property Organization (WIPO) offers mediation and arbitration services for intellectual property disputes, avoiding formal court processes.

iii. Implementing Electronic Case Management Systems:

Electronic case management systems improve the efficiency and accessibility of handling intellectual property (IPR) disputes by reducing paperwork, streamlining processes, and ensuring confidentiality. They also enable real-time tracking of cases, facilitating timely disposal. The European Union Intellectual Property Office (EUIPO) uses an electronic case management system for trademark and design disputes.

(b) Improving Alternate Dispute Resolution (ADR) mechanisms for Intellectual Property Rights (IPR) disputes is crucial for achieving efficient, cost-effective, and timely resolutions.

21.5 ADR mechanisms in India

ADR is a clause in licensing terms that allows parties to agree to undergo it if needed. However, mandating institutionalization may not be desirable and should be left to negotiation parties. Indian courts have introduced Hot Tubbing procedures, with the Delhi High Court incorporating it by substituting Rule 6 in Chapter XI of the Rules. This involves expert witnesses giving evidence simultaneously in the presence of the judge, who questions each expert topic by topic. Issues

not mutually agreed upon are resolved during this process.

21.6 Indian legislators may consider codifying intellectual property disputes due to increased commercial transactions and the need for efficient dispute resolution. However, these provisions may not be applicable if they don't streamline commercial operations.

21.7 Here are key points on how ADR mechanisms can be enhanced:

i. Enhanced Expertise and Specialization: Kindly refer to clause 21.4 (ii).

ii. Utilizing Technology for Efficiency:

Technology can improve the efficiency of Alternative Dispute Resolution (ADR) processes, such as online platforms for case management, virtual hearings, and secure communication channels. This can streamline procedures, reduce costs, and provide flexibility in scheduling. It can also overcome geographical barriers and adapt to modern business needs. For instance, the Singapore International Arbitration Centre (SIAC) has successfully incorporated technology into its arbitration processes, demonstrating the efficiency gains achievable through technology in ADR.

(C) Combined response to Q20, 21 & 24

It is felt that the existing patent laws including the IPR framework in India needs to be certainly strengthened. India needs a robust IPR framework if it aspires to become a Global hub for R & D and innovation

Some of the measures that are suggested to be included in the IPR framework would be:

- The Reliability and Predictability of the IPR Regime should be improved.
- There should be an assured IPR Regime with protection of patents/ SEPs.
- This includes compliance and respect for international framework to deal with Standard Essential Patents (SEPs) based on FRAND principles

The Indian telecom sector needs a balance between rewarding innovators and disseminating technology through licensing and cross-licensing. SSOs promote chip-level licensing and FRAND, enabling growth. However,

imposing price control on royalties or charging on the smallest component can devalue Standard Operating Procedures (SEPs), reducing investment in R&D and innovation. The IEEE's modified patent policies have led to negative letters of assurance, with 42% of companies unwilling to pledge SEPs. Overemphasis on SEP licensing could harm the collaborative standard setting ecosystem.

Q22. Whether there is a need to introduce IP-backed financing system in India for ICT sector?

If yes, what could be the framework to recognize IP as a collateral? Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A22. BIF Response

22.1 Yes, there is a need to introduce an IP-backed financing system in India for the ICT sector. For startups filing patents in India, it costs approximately Rs 1600/- and total cost of granting and maintaining patents is approximately Rs 100000/- for 20 years. And, for filing, granting, and maintaining patents in Europe and USA is very costly it is about $15000/- per patent for 20 years for each Europe and USA. Hence, Total cost of filing, granting, and maintaining patents in India, USA, and Europe is about $31000/- per patent for 20 years.

22.2 Introducing an Intellectual Property (IP)-backed financing system in India for the Information and Communication Technology (ICT) sector is essential to leverage the value of intellectual assets and promote innovation-driven economic growth. Recognizing IP as collateral can unlock financing opportunities for businesses with valuable intellectual property portfolios. Government is doing a lot of handholding for startups to help finance cost of filing patents and also maintaining them. Government's 5GHLF Report and the recently released 6G Vision Document are outstanding examples in this regard.

22.3 Here's a framework with key points, along with examples and best practices from India and abroad:

i. Establishment of Clear Legal Framework:

The goal is to establish a legal framework that acknowledges intellectual property rights as valid collateral for financing, requiring amendments

to financial regulations and a standardized process for valuing and leveraging IP assets. Examples include the U.S.'s Uniform Commercial Code (UCC) and China's policies supporting IP as collateral, with the State Intellectual Property Office (SIPO) and financial institutions collaborating to establish a comprehensive credit evaluation system for IP-backed loans.

ii. Valuation Mechanisms for IP Assets:

The framework for valuing intellectual property assets involves standardized mechanisms, such as the European Patent Office (EPO) and the World Intellectual Property Organization (WIPO). These organizations provide guidelines and resources for assessing the economic worth of patents, trademarks, and copyrights, ensuring accurate assessment and easier use of IP assets as collateral.

iii. Creation of IP Exchanges or Platforms:

The UKIPO and Japan Patent Office are exploring the creation of dedicated IP exchanges or platforms to facilitate the trading and financing of intellectual property assets. These platforms connect IP holders with potential investors or lenders, creating a marketplace for IP-backed financing. The aim is to create a supportive ecosystem for businesses seeking financing through their intellectual property.

Global Leaders in R&D

Q23. What measures should be taken to strengthen international collaborations in the field of STEM by the Government of India?

Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A23. BIF Response

23.1 Strengthening international collaborations in the field of Science, Technology, Engineering, and Mathematics (STEM) is crucial for India's scientific and technological advancement. The Government of India can adopt several measures to enhance such collaborations. Here are key points supported by examples and best practices from India and abroad:

a) Establishment of International STEM Networks and Platforms:

India can foster international collaboration in STEM by actively participating in international networks and platforms like the International Science Council (ISC) and the European Research Council (ERC). These platforms can facilitate knowledge sharing, best practices, and collaborative project opportunities. India can also explore similar frameworks to provide financial support for researchers in cutting-edge STEM projects.

b) Expansion of International Joint Research Programs:

Expand and promote joint research programs with global research institutions, focusing on specific STEM domains. This can enhance international collaboration. For instance, the UK-India Education and Research Initiative (UKIERI) supports collaborative projects between India and the UK, while Germany's Federal Ministry of Education and Research (BMBF) supports joint research projects in science and technology.

c) Enhanced Funding Opportunities for International Collaboration:

Increase funding opportunities and incentives for STEM researchers and institutions in international collaborations, including dedicated grants, fellowships, and research funds. India can emulate the US National Science Foundation and UK Newton Fund, which provide funding for joint initiatives and attract global talent for collaborative STEM endeavors. India can explore creating similar funds to enhance financial support for international STEM collaboration.

d) Creation of Joint Academic Programs and Exchange Initiatives:

The measure is to foster joint academic programs and exchange initiatives between Indian institutions and international universities, such as developing dual-degree programs and joint research centers. This can strengthen academic ties and foster STEM research partnerships, similar to the Erasmus+ Programme and the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA).

e) Promotion of Public-Private Partnerships (PPPs) in International STEM Projects:

The measure is to promote public-private partnerships for international STEM projects, involving government institutions and private

enterprises. This can accelerate innovation and technology transfer. Examples include the Japan-India Industry Academia Collaborative R&D Program and the European Institute of Innovation and Technology (EIT), which promote collaboration between academia, research, and industry. Similar models can be explored in India.

Q24. What are the best practices which need to be adopted by India to promote private sectors investment in R&D activities?

Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A24. BIF Response

24.1 To become a global manufacturing hub, a strong R&D base is crucial. The government has implemented incentives for design-led R&D and local chip and semiconductor manufacturing. However, R&D companies face challenges due to the long development process, which typically takes 1-2 years. Simplifying permissions and approvals for experimental licenses and spectrum is essential for R&D companies to succeed.

24.2 The Atmanirbhar program aims to develop new technologies in India, but the current approval processes for capital goods for R&D need to be addressed. With 5G deployment, new devices and ecosystems are needed, and global opportunities to develop new technologies and products under Make in India and Design in India programs should not be missed.

24.3 The policy should prioritize incentivizing local R&D in the rapidly changing telecom industry. Simplifying procedures for importing capital equipment to set up R&D labs in India is crucial for promoting growth of telecom infrastructure and allowing India to become a global R&D hub. This could lead to a loss of opportunities in the development of 5G technology, particularly in the context of the rapid technological changes. Therefore, the policy should focus on promoting local R&D capabilities.

24.4 India faces challenges in developing as a telecom R&D hub due to difficulties in importing used capital equipment for lab setup. The Ministry of Environment and Forest and Ministry of Electronics & Information Technology have restricted import of older electronics equipment under e-waste policy guidelines, requiring re-export within three years.

24.5 Global companies establishing R&D labs in India often use old capital

equipment, which requires shifting between different labs globally during testing and project phases. To facilitate business, capital goods for R&D purposes should be allowed under the 'free to import' category, with no further sale or commercial transaction value. This would incentivize global companies to continue their operations in India and encourage new companies to open or relocate their global R&D centers. This would generate more employment, skilled workers, and help India become a training hub for LDCs and a global R&D hub.

24.6 The Government could implement a similar scheme to PLI in Manufacturing to make India a global R&D hub. Despite increased funding, it remains insufficient for university-based researchers. Understanding the science and technology ecosystem is crucial for R&D performance. The central government primarily carries over half of India's R&D expenditure.

24.7 Promoting private sector investment in Research and Development (R&D) activities is crucial for fostering innovation, economic growth, and technological advancement. To incentivize and encourage private sector participation in R&D, India can adopt several best practices. Here are key points illustrating these practices:

i. Financial Incentives and Tax Benefits:

The UK's R&D tax credit scheme has been instrumental in encouraging private sector investment in R&D, contributing to the country's technological advancement. This includes tax credits for eligible expenditures, accelerated depreciation on R&D assets, and grants for collaborative research projects. This best practice encourages private enterprises to invest in innovation.

ii. Industry-Academia Collaboration and Technology Clusters:

Promoting collaboration between industries and academic institutions can create technology clusters or innovation hubs, facilitating knowledge exchange, skill development, and joint R&D projects. Silicon Valley, USA, is an example of a technology cluster where tech companies, startups, and academic institutions collaborate closely, driving technological advancements and attracting private investment in R&D.

iii. Streamlined Regulatory Processes and Intellectual Property Protection:

Promoting collaboration between industries and academic institutions can create technology clusters or innovation hubs, fostering knowledge exchange, skill development, and joint R&D projects. Silicon Valley, USA, is an example of a technology cluster that drives technological advancements and attracts private investment in R&D.

iv. Innovation Funding and Grant Programs:

Establish dedicated funds and grant programs for private sector innovation and R&D, including competitive grants, innovation challenges, and sector-specific funding. Israel's Office of the Chief Scientist (OCS) has successfully implemented this approach, positioning the country as a global innovation hub.

Q25. Is there a need to introduce avenues for continuing patents in India such as provisions like "*Continuation-in-part Application*" in the USA?

Please support your answer with justification, strategies and best practices in India and abroad in this regard.

A25. BIF Response

25.1 In the USA, a continuation-in-part (CIP) application allows an inventor to file a new patent application that includes some or all of the subject matter of a previously filed application while also introducing new subject matter. This allows inventors to further protect and refine their inventions.

25.2 In India, the patent system is governed by the Patents Act, 1970, and the rules and regulations derived from it. The Indian patent system primarily follows a first-to-file system, and the concept of a CIP application is not part of the existing framework.

25.3 The Indian legislature has provided all necessary tools for innovators to continue innovation and protect their patent rights. The "Patent of Addition" provision under Section 54, similar to continuation-in-part applications in the US patent system, allows innovators to file for protection of improvements made on the parent application. The Indian patent system also has provisions similar to US continuation applications, allowing subject matter "disclosed" in the parent application to be covered under one or more further applications by dividing the parent application under Section 16.

25.4 India does not have a direct equivalent to the "Continuation-in-part (CIP)

Application" as found in the USA. However, the Indian patent system does provide provisions for continuing patents through divisional applications and Patent Cooperation Treaty (PCT) applications. Here are points to illustrate it:

i. Diverse Nature of Inventions:

Innovation involves continuous development of technology or products, necessitating ongoing patent applications to cover evolving aspects. In India, applicants can file divisional applications to address diverse inventions from a single application. Best practices include conducting regular reviews of the technology landscape to identify new developments or improvements requiring separate protection.

ii. Dynamic Business Strategies:

Businesses need to obtain additional patent protection for modifications, variations, or enhancements to their original invention, especially in industries with rapid technological advancements. Proactive patent portfolio management, regular reassessments, and strategic application filings align intellectual property strategies with business goals.

iii. Global Patent Strategies and PCT Applications:

PCT applications offer flexibility in obtaining global patent coverage for inventions with international relevance. They allow applicants to assess commercial viability in various countries before filing individual national applications, making them a best practice for global patent strategies.

Q26. In view of the best practices being adopted by the global leaders in R&D in general and ICT in particular, which are the policies, programs and incentives which need to be adopted by India?

Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

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Q.30.

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Q.36.

A26. BIF Response

26.1 The knowledge-based industry needs to expedite the protection of intellectual property (IP) and resolution of IP-related disputes. To expedite these processes, several suggestions have been proposed, which require changes at the policy and regulation level. However, no changes are needed at the governance level, as subject matter relevant to business aspects should be regulated by free market forces and guided by global industry practices. Governments should not interfere in licensing engagements between SEP holders and implementers, as global jurisprudence and prevalent industry practices guide such engagements.

26.2 Government intervention may be difficult due to the lack of relevant resources. If disputes arise due to parties' failure to reach a common ground, they can be handled by courts, providing a mechanism for resolution. No governance interventions are needed, as it may go beyond the government's mandate.

26.3 India could adopt provisions such as PPH and focus on reducing administrative burden on patentees, such as section 8 and working statement requirements under form 27. Efficient and timely training of examiners to appreciate incremental inventions would make India a more sought-after destination for patent filing.

Q27. What should be the regulatory framework for R&D efforts in the ICT sector for establishing an outcome-based measurable system?

Please suggest changes required in the present laws or creating new policies or regulatory frameworks with regard to carrying out R&D, testing of products allotment of spectrum and commercializing of products in ICT Sector.

A27. BIF Response

27.1 Establishing an outcome-based measurable system for Research and Development (R&D) efforts in the Information and Communication Technology (ICT) sector requires a regulatory framework that promotes accountability, innovation, and the effective translation of research into tangible outcomes. Here are key points for such a framework:

i. Strategic Key Performance Indicators (KPIs) for R&D Projects:

The UK's Industrial Strategy Challenge Fund incorporates strategic Key Performance Indicators (KPIs) into its funding programs, requiring projects to meet specific objectives related to innovation, economic impact, and collaboration. These KPIs provide a clear roadmap for

measuring the success and impact of ICT R&D projects, aligning them with the overall objectives of the ICT sector. The goal is to ensure that funded projects contribute meaningfully to technological advancements, economic growth, and societal benefits.

ii. Continuous Monitoring and Evaluation Mechanism:

The regulatory framework should incorporate a continuous monitoring and evaluation mechanism for R&D projects, allowing adjustments based on project progress, emerging technologies, and market demands. This ensures projects remain on track, enables early identification of challenges, optimizes resource allocation, and provides timely support for high-potential projects. Singapore's RIE Framework emphasizes continuous monitoring, reallocating resources, and aligning with national priorities.

iii. Outcome-Based Funding Allocation:

The transition to an outcome-based funding allocation model within the regulatory framework encourages efficiency by allocating funds based on the achievement of predefined outcomes and milestones, rather than relying solely on input or expenditure levels. This approach motivates researchers and organizations to focus on delivering measurable results, fostering a culture of innovation and accountability within the ICT sector. For example, Australia's National Innovation and Science Agenda (NISA) emphasizes outcome-based funding through initiatives like the Entrepreneurs' Programme, promoting a results-oriented approach in R&D projects.

27.2 Enhancing the regulatory framework for Research and Development (R&D), product testing, spectrum allocation, and commercialization in the Information and Communication Technology (ICT) sector requires a comprehensive approach. Here are three suggested points for changes or additions to the existing laws and policies:

i. Integrated Regulatory Approach for Spectrum Allocation and R&D Support:

The proposed change aims to link spectrum allocation policies with R&D initiatives by creating a regulatory framework that incentivizes ICT companies to invest in R&D activities as a condition for spectrum allocation. Specific criteria should link spectrum availability and exclusivity to ongoing R&D efforts, encouraging companies to

contribute to technological advancements and ensuring spectrum resources are utilized for ICT sector advancements.

ii. Establishment of a National ICT Innovation Fund:

The proposed change is to establish a National ICT Innovation Fund, funded by regulatory mechanisms, to support R&D projects, product testing, and commercialization efforts. This fund should establish transparent criteria for access, ensuring companies engaged in innovative R&D activities receive financial support for product development, testing, and market entry. This fund can reduce the financial burden on companies, especially startups, and facilitate the transformation of research outcomes into commercially viable products. Similar to Israel's Office of the Chief Scientist (OCS) Fund, a dedicated ICT innovation fund could also facilitate this process.

iii. Streamlined Product Testing and Certification Processes:

Proposes regulatory reforms to streamline product testing and certification processes, creating a unified framework to ensure compliance with standards and minimize bureaucratic hurdles. This approach aims to reduce time-to-market for innovative products and prevent regulatory compliance from hindering commercialization of R&D-based products. For instance, a streamlined process for obtaining European Conformity (CE) marking in the EU promotes market access and innovation.

Q28. In the context of India, whether top-down or bottom-up approach, or combination thereof should be preferred to facilitate indigenous R&D?

Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A28. BIF Response

28.1 In the context of India, a combination of both top-down and bottom-up approaches is often considered the most effective strategy to facilitate indigenous Research and Development (R&D). Here are key considerations:

i. National Missions for Strategic Direction (Top-Down):

The National Solar Mission in India, launched as part of the National Action Plan on Climate Change, aims to promote solar energy development and use in the country. It emphasizes top-down planning

and significant funding. Best practices include clearly defining the mission's goals, allocating dedicated funding, and involving relevant stakeholders. The mission's objectives should be regularly assessed and adjusted based on evolving needs and advancements, ensuring a strategic direction for the renewable energy sector.

ii. Grassroots Innovation and Startups (Bottom-Up):

The Honey Bee Network in India is an example of a grassroots initiative that supports startups and SMEs through bottom-up initiatives. It focuses on identifying, documenting, and supporting grassroots innovations and traditional knowledge, emphasizing the importance of bottom-up innovation.

Best practices include establishing incubators, innovation hubs, and funding mechanisms tailored to support startups and innovators at the grassroots level, encouraging collaboration, mentorship, and knowledge sharing to nurture a vibrant innovation ecosystem.

iii. Public-Private Partnerships and Collaborative Ecosystems (Combination):

The European Institute of Innovation and Technology (EIT) is an example of a collaborative ecosystem that uses both top-down and bottom-up approaches through public-private partnerships. This approach enhances resource utilization and accelerates the translation of R&D into practical applications. Best practices include fostering collaboration between government agencies, private enterprises, and academic institutions to create a comprehensive innovation ecosystem, enabling knowledge exchange, joint R&D projects, and technology transfer.

In conclusion, a balanced approach that integrates top-down strategic planning with bottom-up innovation is crucial for facilitating indigenous R&D in India. National missions provide a strategic roadmap, grassroots initiatives encourage diversity and inclusivity, and collaborative ecosystems leverage the strengths of various stakeholders. This combination ensures a dynamic and responsive environment for innovation, fostering sustainable growth in the R&D sector.

Q29. Apart from the measures indicated under New Education Policy (NEP) what additional measures should be taken to establish a framework at initial stages of education to encourage students for opting

experiment-based learning (learning by doing), rather memory-based learning?

Please provide your answer quoting the best practices being followed internationally.

A29. BIF Response

29.1 The TSR Subramanian report aims to improve India's education quality by entrusting teacher selection to an independent body, promoting technology use, increasing public expenditure, and allocating 6% of GDP for education. It also emphasizes international linkages in higher education, encouraging collaborations and joint research programs.

29.2 Promoting experiment-based learning, also known as "learning by doing," is essential to foster critical thinking, creativity, and problem-solving skills among students. In addition to the measures outlined in the New Education Policy (NEP), here are three additional measures that can be taken to establish a framework at the initial stages of education to encourage students for experiment-based learning:

i. Incorporate Project-Based Assessments:

Project-based assessments are a method that encourages students to apply theoretical knowledge through hands-on projects, fostering a deeper understanding of subjects. They shift the focus from rote memorization to practical application, allowing students to experiment, analyze, and synthesize information. Finland's Phenomenon-Based learning approach, which involves interdisciplinary projects, is an example of this approach, promoting holistic understanding and practical application of knowledge in real-world problems.

ii. Establish Innovation Labs and Maker Spaces:

Innovation labs and maker spaces in educational institutions should be established with tools, technologies, and resources to encourage hands-on experimentation and creation among students. These spaces should be accessible to students across various grade levels, fostering collaborative problem-solving and exploration of ideas. Singapore's Learning Pods, equipped with technology and tools, is an example of an international best practice in promoting hands-on learning in STEM concepts.

iii. Facilitate Industry and Community Partnerships:

The measure involves fostering partnerships between educational institutions, industries, and local communities through workshops, mentorship programs, and collaborative projects. This approach provides students with practical application of their studies and interacts with professionals who can offer insights into experimentation in various fields. Germany's dual education system, which involves close collaboration between schools and industries, is an international best practice, allowing students to gain hands-on experience and understanding of theoretical concepts in the workplace.

By incorporating project-based assessments, establishing innovation labs, maker spaces, and fostering industry and community partnerships, the education system can create a conducive framework for experiment-based learning. These measures not only align with international best practices but also contribute to developing a generation of learners equipped with practical skills and a deeper understanding of the subjects they study.

Q30. What interventions are necessary at policy or governance level to facilitate the growth of knowledge-based industries in India with respect to ICT sector?

A30. BIF Response

30.1 Please also see Response to Q26

Q31. How educational institutions can be linked with industries on long-term basis for basic R&D, development and commercialization of innovative products on self-sustainable model?

Is there any policy intervention also needed? Please support your answer with the best practices being followed in India, or internationally.

A31. BIF Response

31.1 Government needs to facilitate and support establishing industry-academia collaboration platforms, incubation centers, and funding initiatives, that can help forge industry academia partnerships for research and development on a self-sustainable basis.

31.2 The government should play objectively an active role in involving industry professionals in universities for a year or two, as current involvement is mainly cosmetic. Deputing professionals with a good research bent to universities for longer periods could have some impact, but this is rarely done due to commercial reasons. Compensation through

Corporate Social Responsibility (CSR) or other mechanisms could motivate industry to depute professionals for a year. Universities should be more flexible, allowing research students to spend a year in the industry, treating them as researchers rather than additional workers. A research team should be a focal point, guiding young students and encouraging further studies.

31.3 The Ministry of Education is working to increase transparency in research and PhD awards. Every PhD degree awarded by a university must be submitted to a portal called Shodh Ganga. As the portal becomes more user-friendly and classified, it will serve as an effective tool for bringing research work to the public domain and monitoring thesis quality.

31.4 Establishing long-term linkages between educational institutions and industries for basic research and development (R&D), as well as the commercialization of innovative products, requires a strategic and collaborative approach. Here are suggested measures, along with best practices from India and internationally:

i. Industry-Academia collaboration platforms are essential for fostering collaboration between educational institutions and industries. These platforms facilitate regular interaction, joint research projects, and technology transfer. Best practices include Germany's Dual Education System, Stanford University's Industrial Affiliates Program, and Indian Institutes of Technology (IITs) Incubation Ecosystem. These centers provide resources, mentorship, and infrastructure for students, faculty, and industry professionals to collaborate on R&D projects, prototype development, and commercialization efforts.

ii. Joint research projects and funding initiatives are also crucial for fostering collaboration between academic researchers and industry experts. Japan's Industry-Academia Collaborative R&D Programs, supported by the Japan Science and Technology Agency (JST), provide funding and facilitate technology transfer. The European Union's Horizon 2020 Program encourages collaboration between academia and industry across European countries, funding collaborative research projects, promoting innovation and the development of market-ready products.

31.5 In conclusion, establishing industry-academia collaboration platforms, incubation centers, and funding initiatives can foster a culture of entrepreneurship and innovation. These initiatives can help universities

and industries collaborate, develop innovative products, and access funding for commercialization.

Q32. Start-ups are carrying out some outstanding work in all kinds of industries. What additional incentives can be given to start-ups to take up R&D activities in the ICT sector? In this regard, will establishing an exclusive venture capital (VC) fund for ICT help startups in the ICT sector to flourish and prosper in India?

If yes, please provide a mechanism for the same.

A32. BIF Response

The Outstanding R& D work by Academia and Startups in the ICT sector is illustrated below through different examples:

32.1 The 5Gi standard, developed by academia, industry, and the government, showcases India's potential for technology R&D. It prioritizes rural coverage and affordability, focusing on sub-6GHz bands. The Indian consortium, represented by TSDSI, actively participated in the 3GPP standardization process. This success demonstrates India's potential for indigenous innovation.

32.2 CDoT's 4G/5G stack showcases India's ICT R&D capabilities, offering an integrated, cost-effective, and non-standalone solution. This non-standalone implementation enables smooth transitions from existing 4G infrastructure, positioning India as a future leader in next-generation networks. It reduces dependence on foreign vendors, boosts domestic telecom manufacturing, enhances national security, and strengthens India's position.

32.3 ISRO's "frugal innovation" approach, characterized by creativity, resourcefulness, and cost-consciousness, has led to the development of advanced space technologies like sounding rockets, rohini satellites, cryogenic engines, reusable launch vehicles, and software. This approach reduces dependence on foreign technology, offers cost-effective solutions, improves technological competence, and has global leadership potential. It is relevant for developing countries and private space companies. By learning from ISRO's achievements, other sectors and organizations can unlock new possibilities and advance their own technological landscape.

32.4 Digital Bharat Nidhi, established by the Telecommunications Act 2023, aims to drive India's digital transformation, focusing on rural as well as

urban areas. The fund shifts telecommunications regulations to focus on wireless technologies, rural connectivity, data privacy, cybersecurity, and spectrum allocation. It supports R&D for innovation, IP creation, and standards enhancement.

32.5 While there is a provision in Digital Bharat Nidhi Fund for carrying out Pilot Projects, R&D and Innovations, BIF recommend establishing an exclusive venture capital (VC) fund for startups in the ICT sector can significantly boost innovation and R&D activities.

Here are a few additional measures to support startups in the ICT sector through a dedicated VC fund:

i. Specialized ICT Startup Venture Capital Fund:

A specialized venture capital fund should be established to support ICT startups, managed by professionals. This can be achieved through a partnership between government bodies, private investors, and industry associations. Incentives should be offered to attract investors, with matching funds or guarantees provided by the government.

ii. Structured Investment Criteria for ICT Startups:

The proposed mechanism outlines investment criteria for ICT sector startups, considering factors like technological innovation, market potential, scalability, and founding team strength. A transparent application process is established, offering financial incentives like lower interest rates or convertible debt options. Transparent evaluation criteria ensure fair funding access, akin to Singapore's Technology Incubation Scheme, which supports startups in technology-intensive industries.

iii. Mentorship and Ecosystem Support:

In summary, the VC fund should offer mentorship programs, ecosystem support, financial assistance, professional mentorship, industry network access, and accelerator participation. Incentives should encourage entrepreneurs and industry experts to mentor, providing recognition, networking opportunities, and equity stakes. A different model should be explored, encouraging subject-experts-cum-Venture Capitalists to

establish subject-specific Incubation Centers, where they evaluate potential start-ups before providing initial funding. The government may enroll these centers based on credibility, a model that has worked in Israel.

Q33. Suggest ways and means to improve the acceptance of Indian technological innovations globally? Do you envisage the need for a Technology Transfer Organization (TTO) at the national level to help towards commercialization of innovations in ICT?

Please support your answer with justification, frameworks and best practices in India and abroad in this regard.

A33. BIF Response

33.1 Improving the acceptance of Indian technological innovations globally requires a strategic approach that addresses various aspects of innovation, market access, and perception. Here are key means to enhance the global acceptance of Indian technological innovations:

33.1.1 International Collaboration and Partnerships:

The strategy is to boost international collaboration between Indian innovators, research institutions, and global companies through joint research projects, technology transfer agreements, and partnerships with multinational companies. This exposure to global markets, diverse perspectives, and access to resources and expertise validates the quality and competitiveness of Indian technological innovations.

33.1.2. Strategic Branding and Marketing:

India need to enhance strategic branding and marketing strategy to showcase Indian technological innovations globally. This involves creating a strong brand identity, effective communication, and targeted campaigns. Strategic branding positions Indian technologies as reliable, competitive, and unique. Implementation involves investing in branding initiatives, leveraging digital platforms, international conferences, and industry events, and collaborating with marketing professionals.

33.1.3. Compliance with Global Standards and Regulations:

This should be ensured that Indian technological innovations meet international standards, regulations, and quality benchmarks, including industry-specific certifications. This aligns with global norms, allowing Indian innovations to gain easier access and instill confidence among international consumers, businesses, and regulatory bodies. Implementation involves thorough assessments, investment in relevant certifications, and collaboration with regulatory bodies and industry associations to streamline compliance processes.

33.2 Envisaging the need for a Technology Transfer Organization (TTO) at the national level to facilitate the commercialization of innovations in Information and Communication Technology (ICT) is a strategic consideration with several potential benefits. Find key points as below:

33.2.1 Efficient Commercialization Pathway:

Technology transfer involves the transfer of knowledge and innovations from research institutions to the commercial sector. A dedicated Technology Transfer Office (TTO) streamlines this process, creating an efficient pathway for innovators. The Association of University Technology Managers (AUTM) in the U.S. and European TTOs like the Fraunhofer Society and the UK foster collaboration between academia and industry. A national-level TTO can act as a central hub, providing a structured process for evaluating commercial potential, protecting intellectual property, and facilitating partnerships for successful commercialization.

33.2.2 Intellectual Property Management and Licensing:

Effective management of intellectual property (IP) is crucial for successful technology transfer and commercialization. A national-level TTO can handle IP protection, licensing negotiations, and ensure fair compensation for innovators. Japan's JST manages IP and licensing agreements, while the AUTM Global Technology Portal connects inventors, TTOs, and industry partners worldwide. A centralized TTO can efficiently handle IP management, reward inventors, and structure licensing agreements for widespread adoption and commercialization.

33.2.3. Industry Collaboration and Market Access:

A national Technology Transfer Organization (TTO) can facilitate the commercialization of ICT innovations by engaging with industry partners, understanding market needs, and facilitating partnerships. Examples include Yeda R&D Company Ltd. in Israel, which fosters collaborations and licensing agreements, and the Korea Technology Licensing Organization (KTLO) in South Korea, which facilitates the transfer of research-developed technologies to the industrial sector. A TTO can bridge academia and industry, promoting collaboration, identifying market opportunities, and providing access to cutting-edge ICT innovations.

Q34. ICT sector is enabler for fin-tech, health-tech, ed-tech and a host of other applications. In such a scenario, what should be the specific focus areas for R&D in ICT sector? Please support your answer with suitable examples or frameworks and best practices in India and abroad in this regard.

A35. BIF Response

34.1 India has not made significant progress in utilizing Information and Communication Technology (ICT) in agriculture, which is crucial for productivity improvement. However, efforts from student bodies are needed to enhance ICT's effectiveness in the health sector. Image processing for diseases has been done, but more needs to be done through R&D projects. Robotics could be an effective project, and India must address the challenge of making healthcare accessible to everyone at an affordable cost through ICT.

34.2 In a scenario where ICT sector acts as an enabler for various applications such as fin-tech, health-tech, and ed-tech, specific focus areas for Research and Development (R&D) become crucial to drive innovation and advancements. Here are key focus areas supported by examples and best practices:

34.2.1 Interoperability and Standardization:

Interoperability and standardization are crucial for seamless integration and communication between ICT applications. R&D efforts should focus on developing standardized protocols, interfaces, and frameworks to enable collaboration across diverse sectors. The India

Stack Initiative in India aims to create standardized application programming interfaces (APIs) for various sectors, including financial services, healthcare, and education. Standardization and interoperability foster a more cohesive ICT ecosystem, allowing seamless information and service exchange between applications.

34.2.2 5G and Edge Computing:

The adoption of 5G networks and edge computing is crucial for various sectors, including finance, healthcare, and education. South Korea, a pioneer in 5G adoption, is focusing on exploring novel applications like augmented reality in education and telemedicine in healthcare. In the United States, various R&D projects aim to harness the potential of edge computing for low-latency applications, benefiting sectors like finance and healthcare. Advancements in 5G and edge computing will lead to faster, more reliable ICT applications, enabling real-time interactions and innovative solutions in these sectors.

Q35. Is there a need for additional tax or fiscal incentives to support R&D activities in emerging technologies in ICT sector? If yes, please give suggestions with justifications and best practices in India and abroad in this regard.

A35. BIF Response

Please see Response to Q14

Q36. What should be the best practices followed in India to make it a favorable destination for IPR and Patent award nation? Please support your answer with justification, frameworks and best practices in India and abroad in this regard.

A36. BIF Response

Please see Response to Q26

Q37. What measures should be taken for quick disposal of IPR or Patent related disputes? Is there a need to create a specialized legal platform for the same? If so, what steps may be taken to adopt them?

Please provide your answers for above questions, quoting the best practices being followed globally.

A37. BIF Response

37.1 Kindly refer response to Q17 and Q19

37.2 India has improved its intellectual property system by incorporating IP-specific courts and addressing issues like slow case disposal. To become a preferred IPR filing destination, India needs to reduce disposal time by appointing more examiners with legal and technical expertise, continuously updating them with global IP developments, and promoting legal training involving patent practitioners and academicians.

37.3 Further, Rule 24C (1) (i) of the Patent Rules provides that:

An applicant may file a request for expedited examination in Form 18A along with the fee as specified in the first schedule only by electronic transmission duly authenticated within the period prescribed in rule 24B on any of the following grounds, namely:

……

(i) that the application pertains to a sector which is notified by the Central Government on the basis of a request from the head of a department of the Central Government.: Provided that public comments are invited before any such notification;

If required, specific technological sectors, as deemed fit, may be notified under the said provision for being processed through the expedited route, thereby enabling faster grants.

The Indian court system, despite being one of the world's strongest, faces issues such as long pendency of cases and constant rotation of judges. This can result in significant legal costs for litigants, who may have to start fresh before a new judge. This is particularly problematic in intellectual property disputes, where higher stakes are involved. To address this issue, it could be suggested to tie judges to specific matters or increase the time between bench rotations. This could help reduce the financial burden on both parties involved in IP disputes.

Others

Q38. Please comment on any other related issue to promote R&D in the ICT sector in India. Please support your answer with suitable examples and best practices in India and abroad in this regard.

No Comments.

Annexure 1: Analysis of Current Education System and Research & Development in general and that in ICT sector in particular

1.1 Any country's aspiration to become a global economic powerhouse depend on the foundation of a robust industrial sector and its innovative performance. Joseph Schumpeter (1939)[23] emphasized the importance of innovation in promoting economic growth and industrial transformation. Schumpeter's innovation-based endogenous growth model emphasized the role of investment in R&D and human capital.

India aims to become one of the global leader by 2026-27, requiring a US $ 5 trillion Economy. India's government is embracing an ICT-led model for economic growth and development, investing in digital infrastructure and strengthening ICT-based innovations. The "Strategy for New India @ 75" aims to make India one of the top 50 Global Innovation Index (GII) countries and allocate at least 2% of GDP for Research and Development.

1.2 An economy that is steered by innovation across all sectors also requires a conducive innovation ecosystem, which is inclusive and sensitive to the aspirations and needs of the country. An innovation-driven economy can thus be India's key to cement its position as an emerging world leader24. The aspiration of innovation can thus drive firms to increase their productivity and efficiency, thereby achieving growth.

India's ICT sector has witnessed a growth in recent years, with Govt. of India taking a number of policy initiatives to accelerate R&D in the ICT sector. Some of such initiatives includes Make in India, Digital India, Anusandhan National Research Foundation Act-2023[25], a R&D Expenditure Ecosystem and reporting mechanism[26], National web portal for sharing R&D facilities I-STEM[27], National Science, Technology and Innovation Policy (STIP)[28], Atal Innovation Mission, The National Innovation Foundation, and National Science and Technology Entrepreneurship Development Board.

[23] https://discoversocialsciences.com/wp-content/uploads/2018/03/schumpeter_businesscycles_fels.pdf

[24] https://www.niti.gov.in/sites/default/files/2021-01/IndiaInnovationReport2020Book.pdf
[25] https://dst.gov.in/sites/default/files/NRF.pdf
[26] https://www.psa.gov.in/article/rd-expenditure-ecosystem-report-and-actions-taken/3589
[27] https://www.psa.gov.in/i-stem
[28] https://www.psa.gov.in/stip

1.3 India ranks 40th among the 132 economies featured in the Global Innovation Index GII 2023[29].

	GII Position	Innovation Inputs	Innovation Outputs
2020	48th	57th	45th
2021	46th	57th	45th
2022	40th	42nd	39th
2023	40th	46th	35th

As per UNESCO Institute for Statistics (UIS), Accessed service, Sept 2023, reported by World Bank[30], the Research and development expenditure (% of GDP) of India remains noticeably low. India (0.66), China (2.41), Brazil (1.17), USA (3.42).

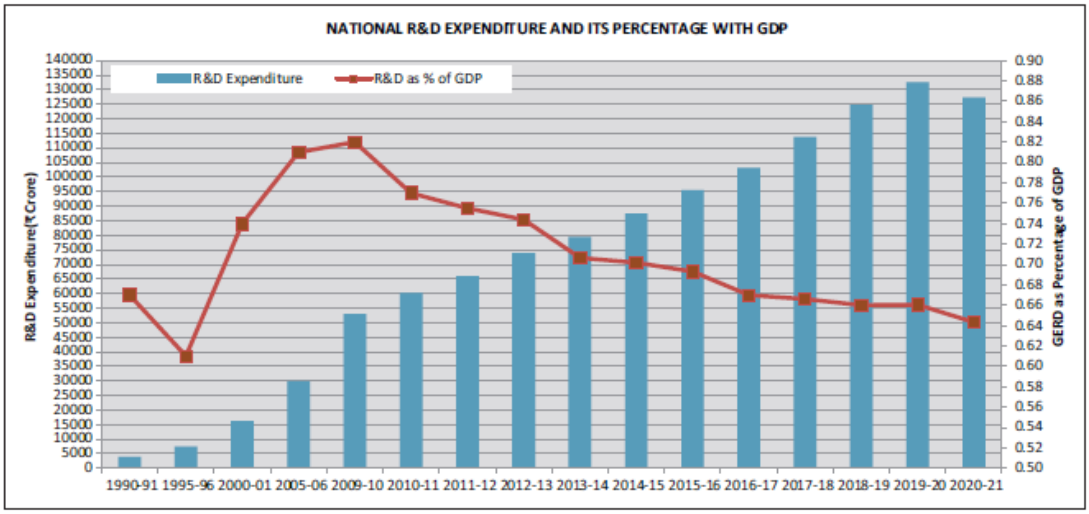
1.4 NITI Aayog in its report, "USING RESEARCH & DEVELOPMENT FOR IMPROVING SCHEME OUTCOMES AND FOSTERING INNOVATION-2022" emphasized, on the process of R&D and innovation needs to be perpetual based on Output-Outcome Monitoring Frameworks (OOMF), assured through the existing institutional mechanisms and due reforms where ever required to make R&D and innovation the mainstay of the Indian economy as has been envisioned under the "Atma Nirbhar Bharat"[31].

1.5 Despite government's efforts, India's ICT R&D lags behind on the global map. As per various studies and reports, India faces persistent challenges like low investment, fragmentation among various ministries and institutions, weak industry-academia ties, limited talent for domain specific research, lack of infrastructure and need for enabling ecosystem for R&D.

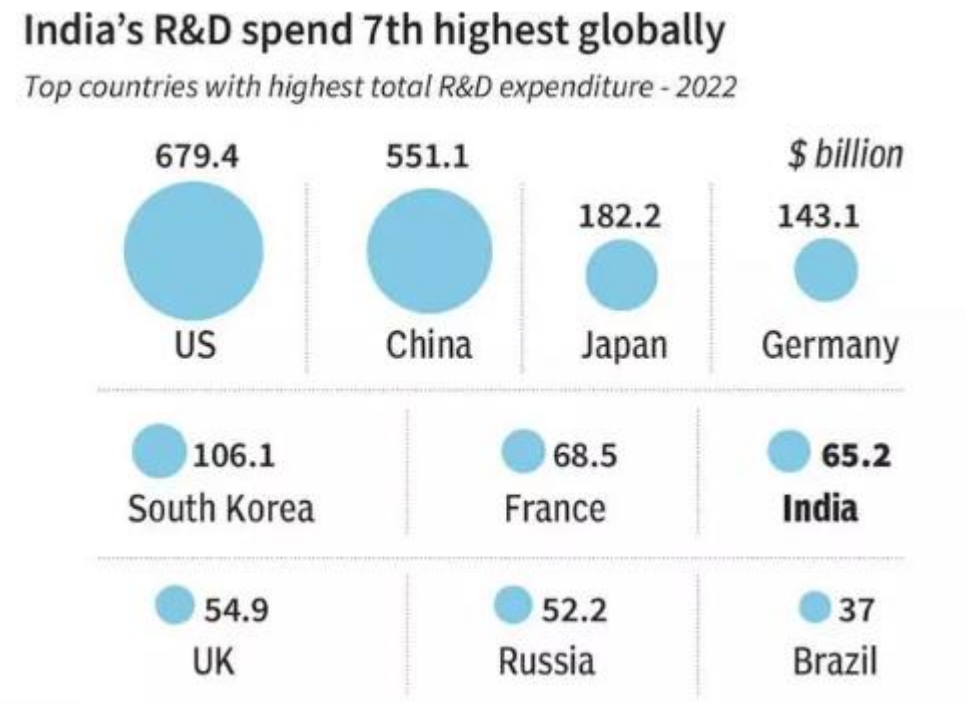
1.6 It is evident that the current education system need certain changes and additional measures are needed to make students effective contributors to R&D and innovations to the ICT industry.

[29] https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023/in.pdf
[30] https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
[31] https://dmeo.gov.in/sites/default/files/2022-06/Thematic%20Report_Research%20and%20Development_02062022.pdf

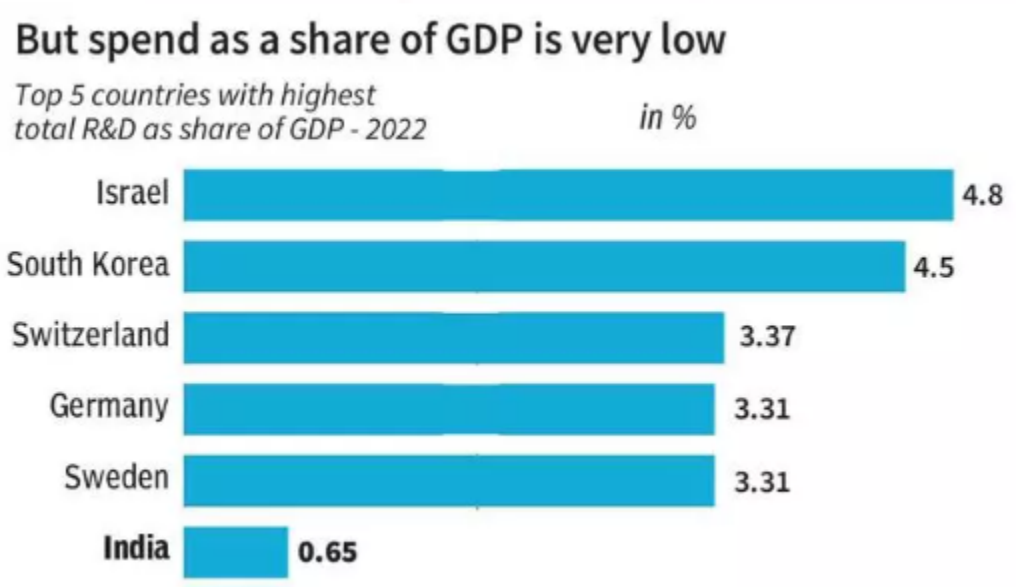
1.7 The Gross Expenditure on R&D (GERD) in the country has been consistently increasing over the years and has more than doubled from Rs. 60,196.75 crores in 2010–11 to Rs. 127,380.96 crore in 2020–21[32].

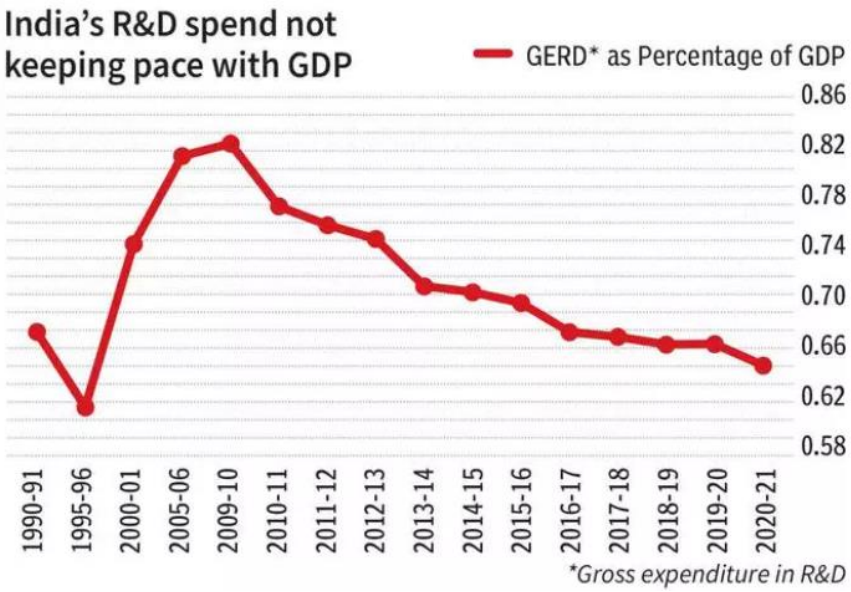


Source: NSTMIS, Department of Science & Technology, Government of India



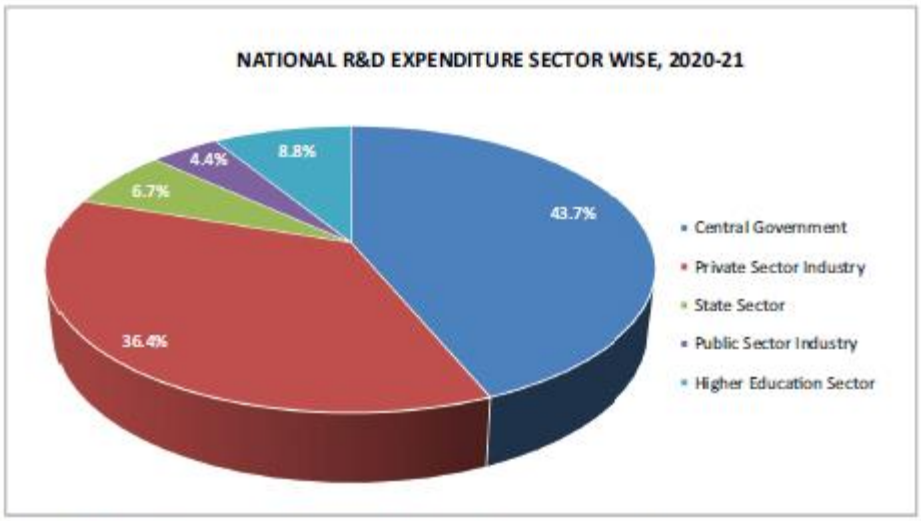
[32] https://dst.gov.in/sites/default/files/R%26D%20Statistics%20at%20a%20Glance%2C%202022-23.pdf





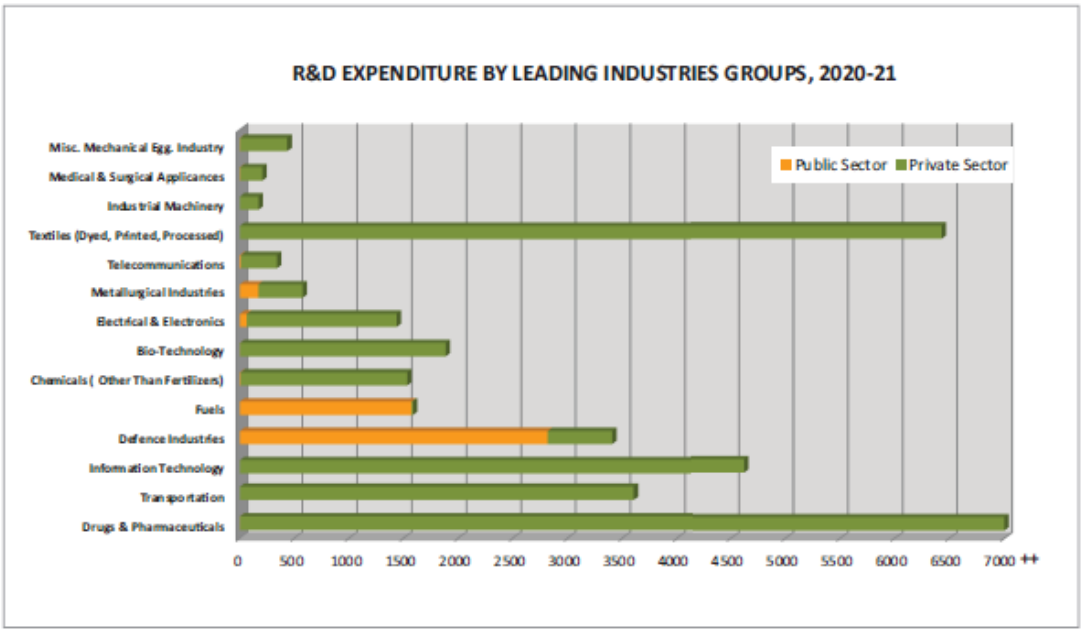
National R&D Expenditure sector-wise 2020-21

1.8 GERD is mainly driven by the Government sector comprising Central Government (43.7%), State Governments (6.7%), Higher Education (8.8%) and Public Sector Industry (4.4%) with Private Sector Industry contributing 36.4% during 2020–21.



Source: NSTMIS, Department of Science & Technology, Government of India

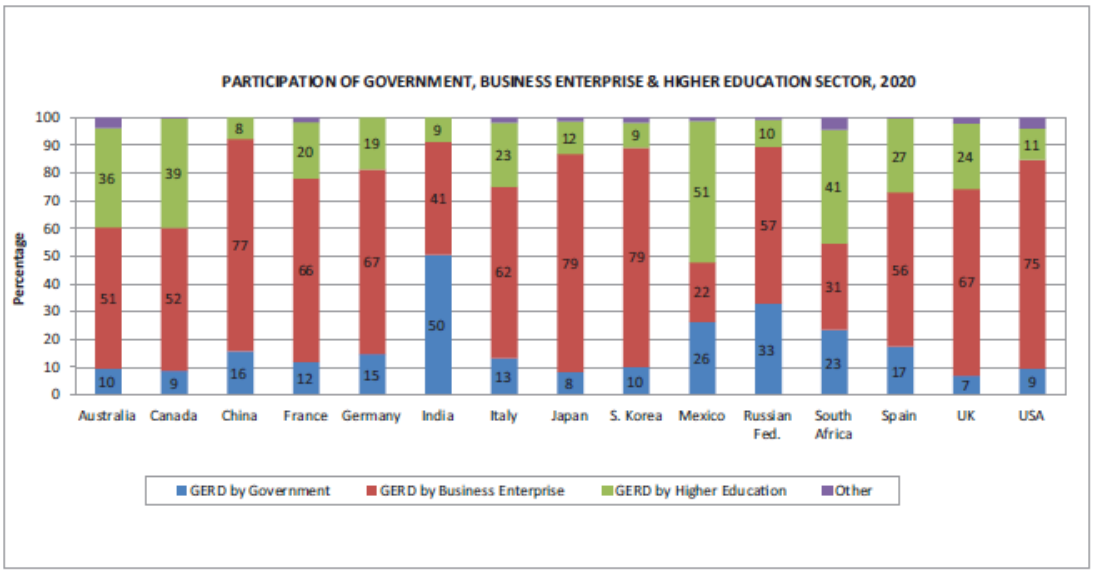
1.9 Information Technology (9.9%), While Telecommunication share is just 1%



Source: NSTMIS, Department of Science & Technology, Government of India

1.10 India stands in contrast with select developed and emerging economies with 59% participation in GERD being made by the government including Higher Education Sector. Though participation of Higher Education Sector in GERD by India is quite low among selected countries.

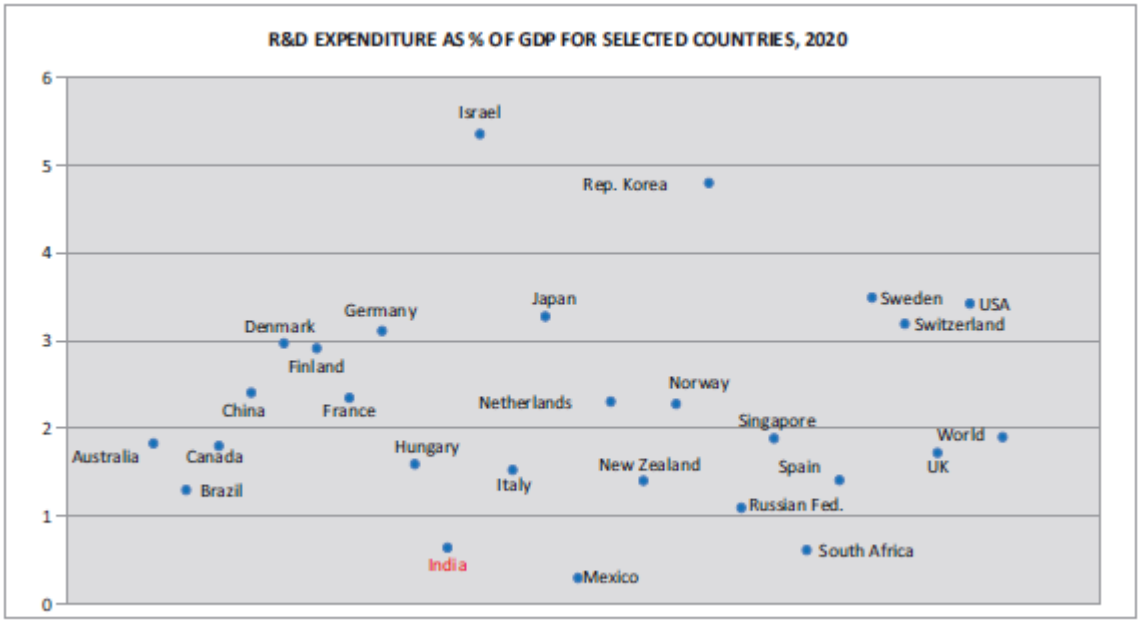
In most of the developed and emerging economies, the participation of Business Enterprises in GERD is generally more than 50%. In fact, it is more than 70% for China, Japan, South Korea and USA.



Source: Main Science and Technology Indicators (MSTI), OECD, September 2022 and India-Data collected and compiled by NSTMIS, DST, GoI
Note: Reference year: 2019-Australia, South Africa, and UK

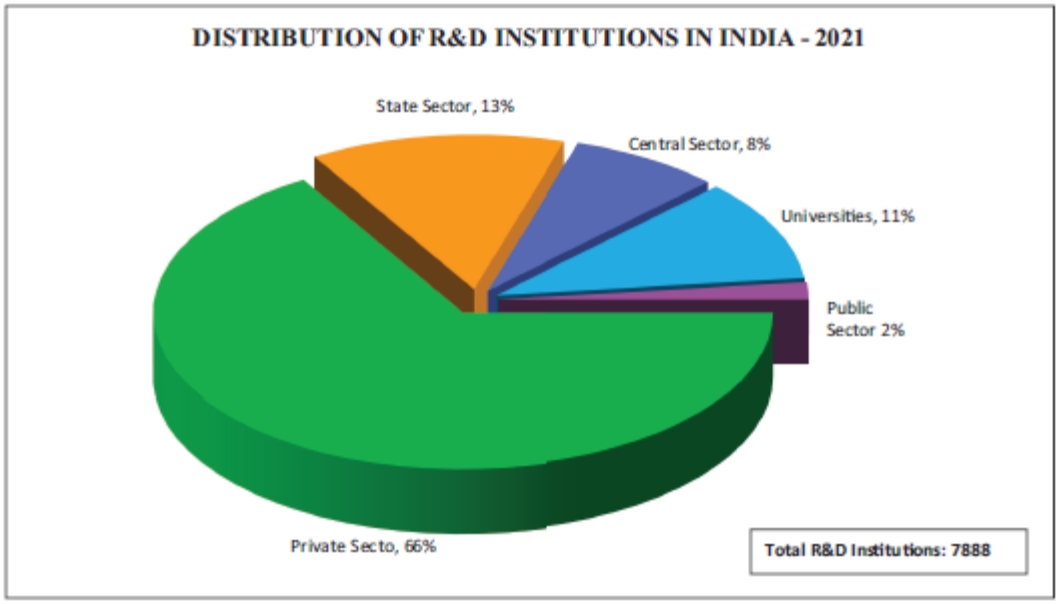
1.11 India spent 0.64% of its GDP on R&D in 2020–21, while the same amongst other developing BRICS countries was—Brazil (1.3%), Russian Federation (1.1%), China (2.4%), and South Africa (0.6%). This ratio was 0.3% for Mexico.

Most of the developed countries spent more than 2% of their Gross Domestic Product (GDP) on R&D.



Source: Main Science and Technology Indicators (MSTI), OECD, September 2022, UNESCO Website & India- R&D Statistics, 2022–23

1.12 As per Directory of R&D Institutions, 2021, there were 7888 R&D institutions in the country, out of which 66% were in private sector.



Source: NSTMIS, DST, Government of India