Promoting Research And Excellence: A Critical Analysis Of India's R&D Policy Framework

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Abstract

With the evolution of mankind, the field of education and research has also revolutionized making education and research an essential and basic necessity of life along with food, clothing and shelter. It is imperative to note that any economy dependent on research and education as its growth driver has shown proven ability of success and development. The present study tries to investigate the research and development scenario in India at different stages of education, the trends and current situation. The study further elaborates upon the issues and challenges India faces in the field of research and education the level of research and development with current statistics and its insufficiency to meet the demand of growing and development levels in India, and importantly, what steps can be taken in order to promote research and development levels in India, comparing with other nations and deriving learnings and best practices for R&D from across countries. Research and development (R&D) leads to innovation and innovation in turn leads to economic growth. India's research and development (R&D) expenditure-GDP ratio of 0.7% is very low when compared to major economies and is much below the world average of 1.8%. Given the importance of R&D for present day economies, detailed analysis and wayforward has been specifically cited which can prove beneficial for India's R&D future.

Keywords: Research, Policy Framework, Innovation, Human Resource, Economic Development.

Literature Review

"Research is creating new knowledge". Research and development is a model of innovation, out of box thinking, creativity undertaken with the purpose of improvement or finding solution to any issue or problem. Since the era of renaissance, which formed the cultivating ground for research and development, giving birth to the industrial revolution. The initial research and development which ignited the engine of growth and provided the importance of R&D.The role of Research and Development (R&D) as a driver of economic growth is irrefutable. Studies have shown that R&D spending can increase productivity and further raise output. The validity of this hypothesis has led to increasing R&D expenditure by almost every government across countries. Sighting the relevance, alongside India's huge chunk of demographic dividend, it can be said that India has untapped potential of human resource, and if combined with appropriate education, research and development can bring huge economic benefit. Analyzing the issues and problems in India's R&D domain at various stages from data collected through various ministries and state government data, the paper tries to provide possible solutions and wayforward for improving the situation and creating fruitful impact on R&D scenarios.

Research and Development: Present Scenario and Policy

- 1. In India, the government undertakes 60% of R&D expenditures, unlike other nations where private enterprise is the primary driver, the country spends around 0.7% of GDP on R&D.
- 2. India's GERD as percentage of GDP remained at 0.66% and 0.64% during the years 2019–20 and 2020–21, respectively.



- 3. India's per capita R&D expenditure has increased to current PPP\$ 42.0 in 2020–21 from current PPP\$ 29.2 in 2007–08.
- 4. R&D expenditure and GDP, in absolute terms, have shown a consistent rising trend over the years. The annual growth rate of R&D (both at current and constant prices) remained higher than that of GDP prior to 2000–01 while fluctuating thereafter.
- 5. GDP since 2009–10 to 2017–18 (both at current and constant prices) has surpassed the annual rate of growth of R&D. One of the reasons could be the revision of the GDP series with a new base year 2011–12 involving a comprehensive coverage of industrial and service sectors, thus leading to higher GDP and its growth rate. From 2017–18 onwards, the annual growth rate of GDP R&D expenditure almost remained the same.



- 6. India's GERD increased to 57.9 billion current PPP\$ in 2020–21 from 50.3 billion current PPP\$ in 2014–15.
- 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 crore in 2010–11 to Rs. 127,380.96 crore in 2020–21.

Analyzing the data, with increasing GDP growth of India, the value of R&D has not been consistent, and has decreased, with India becoming a major world economy and holding the stage for fastest growing nation for many times, the reduced percentage of r&d can be cause of worry. With GDP expansion India needs to expand the base of R&D as well but on a contrary note, the expenditure on R&D has declined.

R&D spending at constant prices has also shown a downfall in previous years, citing the decline in constant rate of expenditure in the field.

Policy Trend: India has identified innovation as a priority. Its national strategy "Decade of Innovations 2010-20" commits to strengthening science, technology and innovation (STI) capacities, with an objective to increase gross expenditure on R&D to 2% of GDP by 2020.

The commitment to innovation is reflected in India's recently launched "Make in India" initiative, which aims to strengthen manufacturing. At the same time, India's 12thFive-Year Plan (2012-17) seeks to catalyze growth for inclusive development.

A National Innovation Foundation supports grassroots innovators, and an Inclusive Innovation Fund (IIF) is expected to mobilize finance to support enterprises developing innovative solutions for the "bottom 500 million".

India has followed sector wise R&D policy for various sectors, e.g.:

- R&D in IT and Electronics: Ministry of Communications & Information Technology Department of Electronics & Information Technology ICT&E R&D and Innovation Framework 2013- The vision of the "ICT&E R&D and Innovation framework" is: To attain global leadership in the ICT&E sector by building a vibrant ecosystem to nurture, encourage, promote, facilitate and support research, innovation and product development for rapid, inclusive and sustainable growth of the country.
 - 1.1. The objective is to promote ICT&E research, innovation, system design and product development especially in cutting edge technologies in areas like Nanoelectronics, Microelectronics, Green computing technologies, PerceptionEngineering and Human Computer Interfaces, Free and Open Source Software ,Networking, Cyber Security etc.
 - 1.2. To promote R&D for the infusion of ICT&E in Industrial sectors in all sectors of the economy.
 - 1.3. To establish Centers of Excellence in thrust areas of ICT&E for intensified and focused R&D activity.
- 2. Research and Development in the Pharmaceutical sector :The recent policy R&D in pharmaceutical sector aims to enable a conducive regulatory landscape to accelerate research & development and drive targeted funding, build strong industry-academia collaboration in line with the global best practices and create best-in-class infrastructure for Innovation in PharmaMedtech sectors. The Policy postulates three main areas for focus to achieve the above objectives. The first is to create a regulatory environment that facilitates innovation and research in product development, expanding the traditional regulatory objectives of safety and quality. The second focus area would be to incentivize private and public investment in Innovation through a mix of fiscal and non-fiscal measures, thereby matching risks with remunerative financing options. The third area of focus will be to build an enabling ecosystem designed to support innovation and cross sectoral research as a strong institutional foundation for sustainable growth in the sector.

India has emerged as one of global supply hubs for pharmaceutical products as seen during covid pandemic, by supplying covid vaccines to nations during peak times at affordable rates. The recent incidence of India's cough syrups causing deaths in Gambia and Uzbekistan has shown the deficit in research in pharma and medicines. This will not only hamper India's image as a global top pharmaceutical supplier but also create trust deficit and reduced exports.

Indian cough syrup: mystery middleman may be new clue

The syrups made by Indian manufacturer Maiden Pharmaceuticals Ltd contained lethal toxins ethylene glycol and diethylene glycol – used in car brake fluid

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3. R&D Infrastructure in Science and Technology: The R&D Infrastructure Division of the Department aims to strengthen the S&T infrastructure of the country by fostering well-equipped R&D labs in the academic/ research institutes/ universities as well as a strong culture of research collaboration between institutions and across disciplines. It has four schemes the objectives of which, at large, are establishment of R&D labs, centers, upgradation of research facilities orienting towards creating a self- reliant India.

With India's success in Space missions the potential of R&D in Science and Technology has been extended, with more expectations for future development and innovation. With limited funding provided to the missions and projects India has set a new level for budget friendly missions, apart from that if India's expenditure is increased in S&T it has the potential to do exceptionally well in the field and challenge other developed nations at their level.

4. R&D in Education: Education forms the basis of research and development. The Indian education system gets contributions from both private as well as government, but over 60% of expenditure is taken over by the government. Education is enshrined as a basic fundamental right guaranteed by the Indian constitution to the people, yet due to lower expenditure poor research contribution is presented on behalf of educational centers. Due to lack of funding, improper infrastructure, lack of technological support, limited resources the educational research is very limited and of poor quality, even if funding is done privately getting research clear from bottlenecks and bureaucratic hurdles remains a challenge for educational institutions and students. Educational research facilities are sometimes so bad that many

educational institutes are unable to provide basic amenities to students and support their initial research and innovation.

5. R&D in Defence: India is one of the biggest importers of defense in the world. With a dynamic and uncertain neighbor, defense expenditure and research both hold importance for the security of the nation. Defense research has been increased over a period of time, which can be seen in developments of indigenous weapons, missiles etc, eg BhraMos missiles. Apart from development in defense India holds potential in exporting such technology and becoming a global exporter from importer of defense equipment.



Issues and Pertaining Challenges:

1. Low GDP Allocation: One of the main reasons for R&D inadequacies in India is the lack of adequate funding for research and development. Government total expenditure on R&D accounts for less than 1% of GDP, India's research and development (R&D) expenditure-GDP ratio of 0.7% is very low when compared to major economies and is much below the world average of 1.8%, which is clearly low and insufficient for a huge country like India. This inadequacy in funding leads to lack of proper resources to research and development which leads to poor quality and inefficient research process. Developing countries tend to have bigger issues like hunger, disease control, and raising the quality of life and authorities divert resources towards tackling them, leading to insufficient funds left for important R&D programs.

On the other hand, private expenditure in India's R&D is also insufficient, private companies are also not willing to invest a significant amount in R&D due to the high risks and

uncertainties involved in the sector. Private players are still hesitant to invest in R&D programs and lack of incentives provided by the government.

A study conducted by NITI Aayog, states the low expenditure on R&D in India as compared to other nations, but also stagnation in R&D pace.

2. Mismatch between Education and Training: India's education system does not adequately prepare students for research and development opportunities. There is not only a mismatch between education and training, but also the level of training is not appropriate to push forward R&D. There is also a lack of training opportunities for researchers to improve their skills and keep up with the latest advances in their fields.

Educational institutions lack training programs for research promotion which leads to delayed or even total absence of research in many fields which creates fake research attempts in mere attempt to complete an educational degree and harms real ground reality about research in Indian institutions.

Much research has shown the poor quality of research and research papers made in Indian institutions. The number of research papers might be high but the quality is poor and below average level. This shows the room of deficiency and inappropriate research promotion in educational institutions in India.

3. Limited Infrastructure: India faces serious challenges in terms of infrastructure capabilities and research facilitation. There are few well-equipped laboratories and research facilities in the country, which limits the ability of researchers to carry out advanced research. This limitation has reduced the capacity as well as quality of research.

Many education institutions lack supportive centers for research and development processes, which not only reduces innovation but also reduces future R&D caliber. In India, there is limited collaboration between academia and industry, which hinders innovation and the commercialization of research. There is also a lack of focus on applied research, which is critical for the development of new products and technologies, and limited infrastructure creates additional hindrance.

4. Bureaucratic Bottlenecks: In India, rigid bureaucratic systems have led to delayed research works, their funding and other approvals, which had been a major cause of poor R&D growth in India.

Many bureaucratic hurdles that researchers must navigate to obtain funding and carry out research projects in India. This bureaucratic red tape slows down the research process and discourages many researchers from pursuing projects in India.

5. Lack of innovation: Lack of innovation and scientific temperament development in the field of R&D has also been a major cause for shortcomings in the field. Lack of innovation leads to low research, which shortens the scope of technological research and further dependency on technological imports and constrained development.

Forbes Study of 2019 stated that 90% of Indian startups will fail because of lack of innovation, citing serious concern for future prospects.

6. Lack of patent and trademark knowledge: India has the lowest number of patents applied compared to many developing and developed countries. The low applications are not only due to lack of knowledge but also difficult procedures, which causes adverse impact in research quality and efficiency.



7. Brain drain and pull factor: There is a lack of adequate expertise in many emerging areas. Further the best talent of our country migrate to foreign countries as they don't get the requisite ecosystem for doing good quality research resulting in brain drain, this results in lower human resource in the country and at the same time quality research also lacks. 8. Gender Gap: in india female participation rate, in field of R&D is significantly less although women participation in extramural R&D projects has increased significantly to 25% in 2019–20 from 13% in 2000–01 due to various initiatives undertaken by the Government in the S & T sector which remains below when compared at international level.



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

9. Lack of motivated researchers: India has proportionately about 18% the number of researchers China has, 5% that of the US, and 3% that of South Korea, policy think-tank Brookings India said in a report. India must take steps in direction to motivate and support more scholars into the research oriented domain.

International Comparison:

- 1. At the international level, most of the developed countries spent more than 2% of their Gross Domestic Product (GDP) on R&D.
- 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.
- As per Science and Engineering (S&E) Indicators, 2022, NSF, USA out of the total 40,813 Doctorates in the country, 24,474 (60.0%) Doctorates were from the S&T discipline during 2018–19. India occupies 3rd rank in terms of the number of PhDs awarded in Science and Engineering (S&E) after the USA (41,071) and China (39,768).

4. Number of researchers per million population in India has increased to 262 in 2020 from 255 in 2017, 218 in 2015, and 110 in 2000.



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

- Amongst the developed countries, Republic of Korea topped the list with 8714 researchers per million population in the world followed by Israel (8342), Sweden (7930), Denmark (7692), Finland (7527) and Singapore (7287) during 2020.
- 6. India's scientific publication output has shown a rising trend during the last decade. India has grown faster than many developed and developing countries such as the USA, UK, Germany, France, Japan, South Korea, Brazil, etc.



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

7. India's research output in publication has increased by 2.5 times from 60,555 in 2010 to 149,213 in 2020 as per NSF database, USA.



GERD as a percentage of GDP

Countries with higher per capita GDP invest more in R&D

Source: UNESCO Institute for Statistics (2018)

- India's growth rate of scientific publication was 9.4% as against the world average of 4.3% during 2010–20 as per the NSF database.
- 9. India's share in global research publication output has increased over the years from 3.1% in 2010 to 5.1% in 2020 as reflected in the NSF database.
- During 2020, India was ranked 3rd in scientific publication output as per the NSF database. India is ranked ahead of many developed and developing countries including BRICS except China.

Key Learnings for India:

1. China's research policy wherein students get funding through state run universities for research and development programs which helps students to undertale innovative research alongside their study, helping boost research and innovation nationally. In the list of top 500

educational institutes in the world compiled by the UK-based agency Quacquarelli Symonds (QS), many more universities from China find a place compared with those from India. As per the latest rankings, 22 Chinese universities found a place in the top 500 list as compared to 9 from India. India can hence learn a lot from China in the respective domain.

- 2. USA educational system and research procedure can provide India with policy formulation in order to improve research efficiency and publish research papers, where the USA is far ahead of India.
- 3. India has the potential to promote research and development at various international platforms, eg BRICS agreement under various domains.
- 4. Learning to foster best talent within the country in order to avoid brain drain to other countries by helping them by providing enough resources for research. Providing scholars with amenities and resources that creates a pull factor for them moving abroad, will reduce loss of talent and help in research contribution.

Steps-Taken and Solution:

Over a period of time the government of India has tried to improve R&D scenarios in India through various policy interventions, through which the government tries to boost finances in research, promoting private participation, improving policy and process for research and approvals. Some of the key measures taken by the government are:

1. Increasing expenditure: Government has tried improving financial flow into the sector, with increasing expenditure, increasing fellowship recently has paved the way in the right direction. This will not only improve research funding, but also boost more human resources towards participation in R&D.



2. National Research Foundation: The National Education Policy (NEP) 2020 suggested the establishment of a National Research Foundation (NRF). The aim is to fund competitive, peer-reviewed grant proposals from the universities, colleges, and institutions of higher learning.



- 3. IMPRINT initiative: IMPacting Research, INnovation and Technology(IMPRINT) scheme is a pan-IIT and IISc joint collaboration. It was launched in 2015. It aims to provide solutions to the most relevant engineering challenges by translating knowledge into viable technology in 10 selected technology domains, thereby creating a push factor for R&D in India.
- 4. Atal Tinkering Labs: It is an initiative of the Niti Aayog under Atal Innovation Mission. It aims to foster curiosity, creativity and imagination in young minds; and inculcate skills such as design mindset, computational thinking, adaptive learning etc.
- 5. Make In India: "Make in India" can be made better by shifting focus to employment in more labor-intensive industries, increasing India's global trade competitiveness, and by the Indian Government fully embracing an ancillary "Innovate in India" campaign focused on facilitating India's rise as a global R&D hub and generating employment for high-skill workers.



Atal Innovation Mission Official @AIMtoInnovate · Feb 16, 2019 · · · Young girls can be seen leading the way in creating innovative solutions to local problems at the #AtalTinkeringLab in Govt Girls Senior Secondary School, Kapurthala, #Punjab.

Here are a few inspiring glimpses of young female innovators at work! #AIMtoInnovate



6. The government plans for the ANRF to have a budget of ₹500 billion (£5 billion) over the five years to 2028. 80% of this is set to come from non-government sources. The Indian government says that the new Anusandhan National Research Foundation (ANRF) will help the country's scientists take a leading role in addressing global challenges. The ANRF will encourage more collaboration between higher education institutions and the private sector.

Some of the possible solutions are:

1. Creating an Enabling Regulatory Environment: The government can create a conducive regulatory environment that encourages private sector participation. This could include measures such as simplifying regulatory procedures, providing incentives for private sector investment, and ensuring a level playing field for all players. The government of India's recent mandate widens the scope of CSR spending to include R&D, which is the right step in the direction.

2. Encouraging Foreign Direct Investment (FDI): The Indian government can encourage Foreign Direct Investment (FDI) by liberalizing investment rules, simplifying procedures, and providing incentives for foreign investors. This can help bring in much-needed foreign capital and expertise to help spur economic growth.



Ministry of Commerce & Industry



India attracts USD 343.64 million FDI equity inflow in R&D sector during 2021, which is 516% higher as compared to 2020

Karnataka is the top FDI Equity recipient state in R&D followed by Telangana and Haryana

Singapore is the top investing country in R&D with 40% share of total FDI Equity in R&D followed by Germany and U.S.A

Robust and growing R&D sector to benefit the economy by driving innovation, increasing productivity, thereby leading to higher economic growth

- 3. Skill Development and Education: The government can invest in skill development and education initiatives to help build a pool of skilled workers that can help support private sector growth. This can help address the skills gap that many private sector players face when trying to expand their operations. Even though India's education sector is one of the biggest in the world, it only contributes a mere 2.7% overall in research. Lack of research incentives, funding from the government or institution, plagiarism problems, redundant publications, and lack of quality.
- 4. Infrastructure Development: The government can invest in infrastructure through building up of research or testing centers, incubation centers,

laboratories, which will help in improving smooth flow of research and reducing infrastructural constraints that reduces research efficiency.

- 5. Public-Private Partnerships (PPPs): PPPs can help in reducing the regional variation and gaps in research related resources and funding which rightnow is a shortcoming for research programs. PPPs can also help in increasing research quality and improve research programs in various fields through collaborations and partnership.
- 6. Audit of funds: Audit of funding provided under various schemes and institutions must be done in order to ensure funds are utilized in appropriate manner, and reached for best use possible and reducing leakages. Funding given to many projects and research work are either not utilized properly or do not even reach at all.

We are aware of several funding agencies to undertake Research work by faculty in many disciplines including University Grants Commission, AICTE etc. But it is unfortunate to hear that the sanctioning authorities expect a share from the total fund needed for the project from the faculty members. If is not done, the fund would not be sanctioned. Some faculty members are able to get the fund one way or the other. The normal share as of now is around 10% to 20% to the authorities, which is being paid through the respective agents.

- 7. Pushing Private Sector: Private sector has a lot of potential resources through which India's research and development can catch a good pace, with investment of private sector R&D can witness:
 - a. Reducing funding discrepancy.
 - b. Reducing shortage of resources
 - c. Can reduce brain drain
 - d. Can help in providing fair chances and reduce regional variation.
- 8. Improving educational research: University Grants Commission has directed every academic institution to establish a Research and Development (R&D) Cell to facilitate networking & collaborations for interdisciplinary and multidisciplinary research, this is sometimes followed only for mere rules with hollow working conditions.

With appropriate followup, regulations, and surprise visits the efficiency of these cells and departments can be improved. This can be improved through tighter guidelines for writing and publishing research work.

9. Improving the quality of PhD papers: The University Grants Commission (UGC) India's statutory body for higher education, has in the past year been reviewing several components of the PhD system, perhaps with the view that today's PhD holder is tomorrow's researcher. The UGC is also considering the removal of the publication requirement for PhD students. Presently, it is mandatory for PhD students' papers to be published in a peer-reviewed journal to be awarded their degree. The quality of research papers can be improved by promoting guided research and better quality data collection for research. However, the timelines for publication in some fields are longer than those in other fields. This causes a delay in the awarding of the degree, keeping students from advancing to the next stage in their careers, thereby leading to much stress. Also, this shifts the responsibility of ensuring the quality of the paper to the journal rather than resting with academics and their supervisors.

Conclusion:

India has the world's highest demographic dividend advantage, if clubbed with appropriate research and development initiatives, not only the human resource capability will be best utilized but will bring additive advantage in the field of technological innovation, indigenous development, sustainable self reliant growth, economic prosperity and also adding to national security. To move from stagnation in R&D to a more dynamic ecosystem would require action on many fronts including greater allocation of funds. Science and technology departments will have to work out how to fast-track decision-making, information sharing, and allow investigators more flexibility in utilizing the funds. This would be the desired path to breed a culture of curiosity and inquisitiveness in the country.

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