Breaking the dichotomy of Indian science: Citizen impact with research excellence

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Independent India has undoubtedly witnessed significant strides in science and technology (S&T) research; however, the tangible impact on everyday citizen life and industry remains limited.

The most enduring metaphor of S&T making a significant impact – the Green Revolution – occurred over five decades ago. More recently, examples like Dr. Abhay Bang's community-based healthcare interventions to reduce infant mortality highlight S&T's potential to address

critical social issues effectively. The space program is another example of success and pride exemplifying the capacity to combine precision-technology with frugality.

However, such examples are few and far between. India is yet to witness industrial advancement driven by indigenous research. In stark contrast, Asian counterparts such as South Korea and Taiwan are leveraging research and development to transform industries, particularly in emerging sectors like semiconductors, propelling economies to new heights. Similarly, Japan is re-booting its efforts in the so-called ‘deep-tech’ areas. This begs the question: does India’s investment in R&D provide adequate returns to the taxpayer?

Meanwhile, many analysts of Indian science point towards our underinvestment in R&D and the need for greater ease of doing Science (EoDS). India's R&D expenditure hovers at a meager 0.64 % of its GDP, compared to over 2% in the case of developed nations. Moreover, the limited funding is skewed, with a disproportionate reliance on public funds (63.6%) as opposed to private sector investments (36.4%), a trend more prevalent in developed countries.

The situation is further exacerbated by underutilization of allocated budgets by government agencies. Additionally, EoDS (as per the report by FAST, India – co-founded by one of the authors) in India remains low, particularly with respect to ‘obtaining’ and ‘utilising’ funds owing to strict regulations – government and institutional, and bureaucratic hurdles and delays pertaining to procurement of research inputs.

Thus, a dichotomy between ‘funders’ and ‘doers’ characterises the Indian S&T ecosystem; wherein the former is dissatisfied with outcomes, while the latter struggles with basic inputs necessary to produce ground-breaking results.

This dichotomy can be transformed into a virtuous cycle through a synergistic framework encompassing three axes: solving for national priorities through ‘Missions’, establishing intellectual leadership in cutting-edge S&T areas, and building capacity for advanced R&D in India.

The first axis, Missions for National Priorities, will develop bold and inspirational S&T Missions focused on national priorities in social as well as economic spheres. These missions will set ambitious yet measurable objectives to be met by S&T innovation. For example, a health mission for the development of vaccines and immunological interventions for diseases where India bears a significant disease burden. Similarly, an economic mission to create of indigenous technology for low-cost batteries with 10% improved storage at 90% weight.

Such missions can be undertaken by one or more of our science departments as well as other ministries such as defence, health and telecommunication, and by collaborative efforts between them. These missions must be executed by defining problems of national interest, identifying S&T gaps, and then engaging the ecosystem of scientists, industry, and research

labs through competitive calls for proposals. Several such efforts have started and include the semiconductor mission the supercomputer mission. But more – including those with social and environmental impact – will be necessary,

The second axis, Leadership in Cutting-edge Areas, will bolster India's intellectual prowess in futuristic areas such as neural-implants, gene-editing, quantum computing, and related fields. This is essential for India to establish itself as an S&T leader in the long term, rather than perpetually playing catchup to Western advances. A baseline capacity in many areas of fundamental research is good, as it creates a community that is truly innovative.

However, India must identify areas for developing excellence and leadership, based on distinctive advantages of geography, intellectual capacity, industry support, and markets. These areas should be identified through bottom-up feedback loops rather than solely relying on arm-chair thinking. India should strategically focus its investments in these areas and create a critical mass of excellent research through competitive grantmaking funding big science.

Finally, the third axis, Capacity Building for Advanced R&D, will build human resources and shared infrastructure (physical and digital) and enable EoDS. This will entail attracting, nurturing, and retaining world-class S&T talent in strategic areas; facilitating the transformation of Indian higher education institutes into Entrepreneurial Universities; providing institutional support mechanisms to ensure continuous training, development, evaluation, and feedback to improve research quality and outcomes; ensuring availability of world-class laboratories, equipment, test-beds, data-trusts, standards, and regulations; and putting in place requisite digital interventions that help make S&T research funding, spending, and reporting more efficient to improve India's EoDS.

These three axes are synergistic and must work in parallel to create a virtuous cycle. For example, let us say, an ambitious yet measurable Mission is formulated. The Mission Director will map the value chain needed for the objectives and identify existing technology, players, and gap areas. The Mission director will work with Program Directors (second axis) to spawn call-for-proposals for developing specific cutting-edge knowledge and technology.

Meanwhile, Capacity Directors will provide horizontal advisory services across Programme Director-managed programmes to build ecosystem capabilities. Government funding will be strategically utilized to crowd in private sector and philanthropic investments to support a particular Mission/Program. As the Mission is served, it will provide RoI simultaneously to the government, industry and citizens, along with improvements in capacity and cutting-edge research outputs.

The proposed three-axes synergistic model can be adopted to further India's goals in climate, industry competitiveness, defence, health and other strategic sectors. It is a win-win for all stakeholders. The recently enacted Anusandhan National Research Foundation Act

presents policymakers with an important opportunity to overhaul the S&T research ecosystem to help India reap windfall gains for decades and centuries to come.

It is a bus, which must not be missed. The opportunity must be leveraged to simultaneously align Indian S&T talent and capacities to help India become a world leader in S&T, allowing it to indigenously exploit the potential of emerging technologies to help achieve national priorities of economic growth, and inclusive and sustainable development, thereby bridging the chasm between research excellence and citizen impact.

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