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Science, Technology and Innovation for Viksit Bharat @ 2047

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ABSTRACT
India aspires to become a developed nation by 2047, marking the centenary of its independence. The vision of *Viksit Bharat @ 2047* represents a comprehensive national commitment to economic prosperity, social justice, technological advancement, environmental sustainability, and improved quality of life for every citizen. Science, technology, and innovation (STI) are central to achieving this aspiration because they enhance productivity, strengthen industrial competitiveness, improve public services, and create solutions to complex national challenges. Developments in artificial intelligence, biotechnology, quantum computing, semiconductors, space science, renewable energy, digital public infrastructure, and advanced manufacturing offer significant opportunities for India's transformation. However, the country must address challenges such as inadequate research expenditure, limited industry–academia collaboration, unequal access to technology, skill gaps, and the slow commercialization of research outcomes. This article examines the role of science, technology, and innovation in realizing Viksit Bharat by 2047, reviews major initiatives and emerging opportunities, identifies structural challenges, and proposes a comprehensive roadmap for inclusive, sustainable, and innovation-driven development. It argues that India must move from being primarily a consumer and adopter of technologies to becoming a leading creator of knowledge, intellectual property, and globally competitive technological solutions.

Keywords: Viksit Bharat 2047, science and technology, innovation, research and development, artificial intelligence, digital transformation, sustainable development, Atmanirbhar Bharat.

Introduction

The development of a nation in the twenty-first century depends not only on its natural resources, population, and economic strength but also on its capacity to generate scientific knowledge, develop advanced technologies, and translate innovative ideas into practical applications. Science provides an understanding of the natural and social world, technology applies scientific knowledge to solve problems, and innovation transforms knowledge and ideas into useful products, services, processes, and institutions.

India's aspiration to become a developed nation by 2047 requires a fundamental transformation of its economy and society. The centenary of independence offers an opportunity to establish a prosperous, technologically advanced, self-reliant, inclusive, and environmentally responsible nation. The vision of Viksit Bharat encompasses improvements in income, education, healthcare, infrastructure, employment, governance, national security, and the overall well-being of citizens.

Science, technology, and innovation can accelerate progress across all these dimensions. Precision agriculture can improve farm productivity, artificial intelligence can support medical diagnosis, digital platforms can improve public-service delivery, and renewable energy can reduce dependence on fossil fuels. Similarly, advanced manufacturing, semiconductor production, robotics, and biotechnology can generate employment, strengthen industrial capabilities, and enhance India's position in global value chains.

India has developed important capabilities in information technology, pharmaceuticals, space exploration, digital payments, and scientific research. Nevertheless, achieving developed-country status requires a broader innovation ecosystem in which universities, research institutions, industries, startups, governments, and citizens collaborate to solve national and global problems.

The central argument of this article is that science, technology, and innovation must be treated not as isolated sectors but as fundamental drivers of India's economic, social, and environmental transformation.

2. Understanding the Vision of Viksit Bharat @ 2047

Viksit Bharat @ 2047 refers to India's ambition to become a developed nation by the year 2047. This vision extends beyond economic growth and includes human development, technological leadership,

institutional effectiveness, environmental protection, and equal opportunities.

A developed India should possess a productive economy, a skilled workforce, modern infrastructure, accessible healthcare, quality education, efficient governance, and strong scientific and technological capabilities. Development should also ensure that rural communities, women, economically disadvantaged groups, and people living in remote regions benefit from national progress.
Science and innovation can contribute to this vision in five major ways.

First, they can increase economic productivity by improving the efficiency of agriculture, manufacturing, transportation, and services. Second, they can create new industries, businesses, and employment opportunities. Third, they can improve the delivery of healthcare, education, financial services, and public administration. Fourth, they can strengthen strategic autonomy in critical sectors such as semiconductors, defence, energy, and telecommunications. Fifth, they can support sustainable development through clean energy, climate modelling, water conservation, and circular-economy technologies.

The Government of India's Emerging Science, Technology and Innovation Conclave (ESTIC) 2025 vision document identifies priority areas that include artificial intelligence, quantum technologies, biotechnology, semiconductors, clean energy, digital communications, and space applications. These areas demonstrate the importance of coordinating scientific research with national development priorities. Source: Department of Science and Technology, ESTIC 2025 Vision Document.
Therefore, Viksit Bharat should be understood as a knowledge-driven development model in which scientific capabilities and technological innovation support prosperity, resilience, and social inclusion.

3. The Role of Science, Technology and Innovation in National Development

3.1 Economic Growth and Productivity

Science and technology contribute to economic growth by improving production methods, reducing costs, increasing quality, and creating new markets. Automation, digital systems, advanced materials, and data analytics enable businesses to produce more efficiently and respond to changing consumer requirements.

For India, technological advancement is particularly important because a large workforce must be absorbed into productive employment. Modern manufacturing, electronics, biotechnology, renewable energy, and technology-enabled services can generate new economic opportunities.

Innovation also enables small and medium-sized enterprises to compete more effectively. Digital accounting, online marketplaces, cloud computing, and automated inventory systems allow smaller firms to reach wider markets and improve their operations.

A strong domestic innovation ecosystem can reduce dependence on imported technologies, improve export competitiveness, and strengthen India's position in global supply chains. However, technology-led economic growth must be accompanied by investment in skills and worker transitions so that productivity gains translate into better employment opportunities and living standards.

3.2 Employment Generation and Entrepreneurship

Innovation creates employment directly through research, product development, engineering, software development, and scientific services. It also generates indirect employment through manufacturing, logistics, maintenance, marketing, and supporting industries.

Startups are important because they transform new ideas into commercial products and services. Indian entrepreneurs are developing solutions in fintech, health technology, agricultural technology, educational technology, electric mobility, and enterprise software.

By 2047, India should encourage a transition from employment primarily based on routine activities to higher-productivity work involving scientific knowledge, technical expertise, creativity, and problem-solving.

Incubation centres, technology parks, research laboratories, innovation competitions, and startup funding can help young entrepreneurs develop and commercialize their ideas. Special attention should be given to rural enterprises, women-led startups, and innovations emerging from smaller cities.

3.3 Social Development and Quality of Life

The value of technology lies not only in economic output but also in its contribution to human welfare.

Telemedicine can connect remote communities with medical specialists. Digital learning platforms can expand access to educational resources. Assistive technologies can improve the independence of persons with disabilities. Digital public services can reduce travel, paperwork, and delays in accessing government schemes.

Technological solutions must nevertheless remain accessible, affordable, reliable, and understandable. Digital services should not exclude people who lack smartphones, connectivity, digital literacy, or proficiency in dominant online languages.

Consequently, the success of Viksit Bharat should be measured not only by the number of patents, startups, or advanced technologies produced but also by improvements in people's lives.

4. India's Current Science, Technology and Innovation Ecosystem

India has established a substantial scientific and technological foundation through universities, Indian Institutes of Technology, Indian Institutes of Science Education and Research, national laboratories, medical research institutions, space and atomic research organizations, and private-sector technology companies.

The country has demonstrated significant capabilities in information technology, generic pharmaceuticals, vaccines, space missions, digital financial infrastructure, and engineering services. These capabilities provide a foundation for further technological advancement.

The Department of Science and Technology, Department of Biotechnology, Council of Scientific and Industrial Research, Indian Council of Agricultural Research, Indian Council of Medical Research, and other institutions contribute to scientific research and technology development.

The Anusandhan National Research Foundation (ANRF), established under the ANRF Act, 2023, seeks to strengthen research and innovation by encouraging collaboration among universities, industries, government bodies, and research institutions. Its

objectives include expanding research capacity, supporting interdisciplinary work, and accelerating the translation of scientific discoveries into useful applications. Source: Office of the Principal Scientific Adviser.

Despite this progress, India must address several structural limitations. Research expenditure remains relatively low compared with that of leading research-intensive economies. Private-sector participation in research and development has historically been limited, and many universities need better laboratories, research funding, and stronger connections with industry.

Another challenge is the gap between scientific discoveries and commercial products. A promising research result may fail to reach society because of inadequate prototype funding, limited industrial testing, insufficient intellectual-property support, or a lack of suitable commercialization partners.

India's task is therefore twofold: strengthen its capacity to produce high-quality scientific knowledge and improve its ability to transform that knowledge into useful technologies at scale.

5. Major Technological Areas for Viksit Bharat @ 2047

5.1 Artificial Intelligence and Machine Learning

Artificial intelligence (AI) is one of the most influential technologies shaping the modern economy. It enables computers to identify patterns, process language, analyze images, make predictions, and support complex decisions.

In agriculture, AI can help estimate crop yields, identify plant diseases, optimize irrigation, and provide weather-related advisories. In healthcare, it can assist with medical imaging, clinical decision support, drug discovery, and disease surveillance. In manufacturing, AI can support predictive maintenance, quality control, and supply-chain optimization.

India should develop AI systems suited to its linguistic diversity, social conditions, and economic requirements. Indian-language AI tools can expand access to digital services for people who are not comfortable using English. AI can also support teachers, researchers, public administrators, and small businesses.

However, AI creates concerns relating to privacy, misinformation, algorithmic bias, cybersecurity, employment displacement, and the concentration of technological power. India should promote responsible AI through transparent governance, rigorous evaluation, human oversight, secure data practices, and public awareness.

The objective should be to make AI a tool for inclusive development rather than a technology whose benefits are restricted to a small number of firms or highly skilled workers.

5.2 Semiconductor and Electronics Manufacturing

Semiconductors are essential components of smartphones, computers, vehicles, medical devices, communication networks, industrial machinery, and defence systems. Reliable access to advanced chips is therefore important for economic competitiveness and national security.

India has opportunities to expand semiconductor fabrication, chip design, assembly, testing, packaging, and electronic component manufacturing. Its engineering workforce and growing domestic electronics market provide important advantages.

However, semiconductor manufacturing requires substantial capital investment, advanced infrastructure, specialized skills, reliable power and water supplies, and long-term technological partnerships.

By 2047, India should aim to develop stronger domestic capabilities across the semiconductor value chain. Universities and industries should cooperate in chip design, materials science, electronic engineering, and manufacturing research. Support for domestic suppliers can gradually strengthen the wider electronics ecosystem.

Success should be evaluated through technological capability, productivity, reliable production, skilled employment, domestic value addition, and export competitiveness rather than factory announcements alone.

5.3 Space Science and Exploration

India's space programme demonstrates how scientific research can contribute to national development. Satellite technology supports weather forecasting, telecommunications, navigation, agriculture, environmental monitoring, and disaster management.

Space missions also advance scientific knowledge and stimulate innovation in materials, electronics, robotics, propulsion, and data processing.

The expansion of private participation in the space sector creates opportunities for startups to develop launch systems, satellite components, Earth-observation services, and space-based applications.

By 2047, India can strengthen its position in satellite manufacturing, reusable launch technologies, space exploration, and commercial space services. Space-derived information can help states and local authorities monitor floods, droughts, forest cover, urban expansion, and coastal changes.

Nevertheless, space activities must remain economically viable, technically reliable, and environmentally responsible. International cooperation can support scientific progress while domestic capabilities strengthen strategic autonomy.

5.4 Quantum Technologies

Quantum technologies use principles of quantum physics to develop new approaches to computing, sensing, and secure communication.

Quantum computing may eventually help address particular computational problems in materials research, chemistry, optimization, and scientific simulation. Quantum sensors may offer improved precision in selected navigation, measurement, and medical applications. Quantum communication research may contribute to specialized secure communication systems.

These technologies are still developing, and their practical benefits vary considerably by application. India must therefore balance ambitious long-term research with realistic assessments of technical maturity.

Investments in laboratories, quantum materials, cryogenic systems, specialized engineering, and advanced scientific training are important. Collaboration between physics departments, engineering institutions, national laboratories, and technology firms can help build a sustainable research ecosystem.

By 2047, India should aim to possess strong domestic capabilities in quantum research and selected commercially useful applications.

5.5 Renewable Energy and Green Technology

Energy security and environmental sustainability are essential elements of developed-country status. India must meet growing energy demand while reducing pollution and managing climate-related risks.

Solar power, wind energy, energy storage, green hydrogen, smart grids, and electric mobility can contribute to a cleaner energy system. Improvements in battery chemistry, power electronics, recycling, and grid management are particularly important.

Scientific research can help reduce the cost of renewable energy, improve the durability of storage systems, and develop materials that require fewer scarce resources.
Electric vehicles can reduce dependence on petroleum in suitable applications, especially when supported by cleaner electricity and effective battery recycling. Green hydrogen may be useful in selected industrial processes where direct electrification is difficult.
India should also invest in energy-efficient buildings, public transportation, industrial efficiency, and technologies that reduce emissions throughout supply chains.

The transition must be economically and socially fair. Workers and regions dependent on traditional energy industries need retraining, alternative employment, and support for economic diversification.

5.6Digital Public Infrastructure

Digital public infrastructure (DPI) includes shared digital systems that enable individuals, businesses, and governments to interact more efficiently. India's experience with digital identity, interoperable payment systems, and digital document services illustrates the potential of large-scale digital platforms.

Well-designed digital infrastructure can reduce transaction costs, support financial inclusion, enable innovation, and improve public-service delivery. Open standards and interoperability can allow multiple service providers to develop useful applications on common foundations.
By 2047, India should strengthen secure digital identity systems, electronic health records where appropriate, digital education resources, agricultural information networks, and accessible government services.

Such systems must be supported by robust cybersecurity, privacy protection, grievance redressal, and inclusive alternatives for people who cannot access digital channels.

Technology should simplify citizens' lives, not create additional barriers or make essential services inaccessible.

6. Science, Technology and Innovation in Key Development Sectors

6.1 Agriculture and Rural Development

Agriculture remains important for livelihoods, food security, and rural economic activity. Scientific and technological innovation can help farmers respond to climate variability, water scarcity, soil degradation, pests, and changing market conditions.

Precision agriculture uses sensors, satellite information, weather data, and digital tools to improve decisions about irrigation, fertilization, and crop protection. Soil testing and targeted nutrient management can reduce unnecessary input costs.

Drones may support crop monitoring and selected agricultural operations, subject to safety and regulatory requirements. Digital platforms can provide market information, weather advisories, and access to agricultural services.

Biotechnology and conventional crop improvement can contribute to productivity and resilience. Cold-chain facilities, improved storage, food processing, and logistics can reduce post-harvest losses and increase farmers' share of value.

Rural innovation must remain affordable and practical. Local-language interfaces, farmer training, reliable maintenance, and cooperation with agricultural universities and extension services are essential for adoption.

6.2 Education and Skill Development

A developed nation requires a scientifically informed population and a workforce capable of adapting to technological change.

Schools should encourage curiosity, experimentation, critical thinking, problem-solving, and scientific reasoning rather than relying exclusively on memorization. Laboratories, science clubs, robotics activities, coding, and project-based learning can help students understand how scientific principles are applied.

Universities should offer interdisciplinary programmes that connect science and engineering with business, public policy, ethics, and social sciences.

Vocational education must also be strengthened. Workers need practical skills in electronics, renewable energy, healthcare technology, cybersecurity, automation, and equipment maintenance.
Digital learning can extend educational resources to remote regions, but it should complement rather than replace effective teachers and practical instruction.
By 2047, India should seek to make high-quality scientific education and lifelong learning accessible to all sections of society.

6.3 Healthcare and Public Health

Technology can strengthen India's healthcare system through affordable diagnostics, telemedicine, electronic records, medical equipment, and improved disease surveillance.

AI-assisted tools may help identify patterns in medical images and laboratory results, but clinical decisions must remain subject to appropriate professional judgment and validation.
Portable diagnostic devices can improve access to basic testing in rural areas. Digital health platforms can support continuity of care when privacy and interoperability are properly managed.

India should expand research in medical devices, biomedical engineering, public-health technologies, and locally relevant treatments. Domestic production can improve supply resilience, provided products meet quality and safety standards.
A technologically advanced healthcare system must combine innovation with accessible primary care, trained personnel, reliable infrastructure, and affordable medicines.

6.4 Water Management and Environmental Protection

Water scarcity, groundwater depletion, pollution, and climate change threaten sustainable development in many parts of India.

Remote sensing, geographic information systems, water-quality sensors, and predictive models can improve monitoring and planning.
Smart irrigation and wastewater treatment technologies can reduce pressure on freshwater resources.
Scientific research can also support rainwater harvesting, watershed restoration, groundwater recharge, and the recovery of useful materials from waste.

Technology alone cannot solve water problems. Effective institutions, local participation, appropriate pricing, conservation practices, and coordination between states are equally important.

By 2047, India should integrate scientific evidence with community-based water management and long-term environmental planning.

7. Major Government Initiatives Supporting Innovation

India has introduced several initiatives intended to strengthen its research and technological capabilities.

Anusandhan National Research Foundation (ANRF): ANRF aims to expand research capacity, encourage collaboration, and support the translation of scientific discoveries into economic and social value. Its role is particularly important in building stronger research ecosystems across universities and institutions. (https://www.anrf.gov.in/)

National Research and Development and Innovation initiatives: The Research, Development and Innovation (RDI) Scheme, approved in July 2025 with an announced outlay of ₹1 lakh crore, is intended to catalyse private-sector investment in high-impact research and strategic technologies. Its priorities include deep technologies, energy transition, climate action, and AI applications. (https://dst.gov.in/rdi-scheme/research-development-and-innovation-rdi-cell)

IndiaAI Mission: The mission supports the development of India's AI ecosystem, including computing capacity, innovation, skills, and AI applications. Its broader significance lies in expanding the ability of researchers and businesses to develop AI systems relevant to Indian needs.

National Quantum Mission: This initiative seeks to develop quantum science and technology capabilities in areas including quantum computing, communication, sensing, and related systems.

India Semiconductor Mission: Semiconductor-related initiatives aim to develop domestic manufacturing, design, and associated supply chains, reducing vulnerabilities in strategically important electronics.

Vigyan Dhara: This Department of Science and Technology umbrella scheme integrates institutional capacity building, research and development, and innovation and technology deployment. Its stated purpose is to strengthen India's science and technology ecosystem and align programmes with national development priorities. (https://www.pmindia.gov.in/en/news_updates/cabinet-approves-

the-department-of-science-and-technology-scheme-namely-vigyan-dhara/)

Startup India: Startup support, incubation, mentoring, and entrepreneurship initiatives can help innovators establish businesses, develop prototypes, and bring technologies to market.

Atal Innovation Mission: Innovation and incubation programmes encourage problem-solving and entrepreneurship among students, researchers, and early-stage businesses.

These initiatives can complement one another when funding, infrastructure, research priorities, and implementation are coordinated. Their effectiveness will depend on sustained support, transparent evaluation, efficient administration, and measurable outcomes.

8. Challenges in Achieving Science- and Innovation-Led Development

8.1 Low Research and Development Expenditure

Scientific progress requires sustained investment in researchers, laboratories, equipment, and long-term experiments. India's research expenditure has historically remained below the levels of many major research-intensive economies.

According to a 2025 parliamentary response based on earlier official statistics, gross expenditure on research and development was approximately 0.64% of GDP in 2020–21. This historical figure should not be mistaken for the latest expenditure level, but it illustrates the long-standing challenge of scaling research investment.

India needs predictable, long-term research funding alongside stronger private-sector participation. Increased expenditure should be accompanied by accountability, research quality, and effective allocation of resources.

8.2 Weak Industry–Academia Collaboration

Universities and research institutions often operate separately from commercial and industrial needs. As a result, useful discoveries may remain confined to academic publications without being converted into products or services.

Joint laboratories, industrial PhD programmes, collaborative research projects, technology-transfer offices, and shared testing facilities can help bridge this gap.

Industries should communicate technological problems to researchers, while universities should retain sufficient independence to pursue fundamental research. Both basic science and application-oriented research are necessary for long-term progress.

8.3 Brain Drain and Talent Retention

India produces large numbers of graduates in science, engineering, medicine, and information technology. However, some highly skilled researchers move abroad because of better research facilities, funding opportunities, career prospects, or professional environments.

The solution is not simply to discourage international mobility. Instead, India should create attractive conditions for research through competitive grants, modern laboratories, merit-based recruitment, professional autonomy, and international collaboration.

Researchers working abroad should also be encouraged to collaborate with Indian institutions through joint appointments, visiting programmes, and collaborative laboratories.

8.4 Ethical, Security and Environmental Risks

Emerging technologies can produce unintended consequences. AI systems may reproduce bias, digital platforms may expose personal information, and poorly governed biotechnology may create safety risks. Industrial expansion may also increase resource consumption and electronic waste.

Strong regulation, independent oversight, safety testing, cybersecurity, environmental assessment, and public participation are essential.

India must develop the capacity to innovate rapidly without compromising human rights, public safety, environmental protection, or democratic accountability.

9. Strategies and Roadmap for Viksit Bharat @ 2047

9.1 Increase Investment in Research and Development

India should pursue a sustained increase in research expenditure through coordinated public and private investment. Public funding should support fundamental science, high-risk research, university laboratories, and projects with significant social benefits.

Private firms should be encouraged to invest in product development, advanced manufacturing, industrial research, and deep technology. Competitive grants appropriately designed co-funding arrangements, and stable research policies can help mobilize resources.

Funding systems should support promising ideas over realistic development periods rather than rewarding only short-term outputs.

9.2 Strengthen Universities and Research Institutions

Universities should become major centres of scientific discovery and technological innovation. This requires modern equipment, well-trained technical staff, reliable research funding, and supportive institutional leadership.

Research institutions should promote interdisciplinary collaboration and allow scientists to work across departments and organizations.
Performance evaluation should consider research quality, reproducibility, societal impact, patents where appropriate, technology transfer, and the development of young researchers.
India should also strengthen research capacity in state universities and colleges instead of concentrating opportunities in a limited number of institutions.

9.3 Promote Startups and Deep-Tech Entrepreneurship

Deep technologies, including advanced materials, robotics, biotechnology, quantum systems, and semiconductor technologies, often require long development periods and substantial capital.
India should provide appropriate support through incubation centres, specialized laboratories, proof-of-concept grants, patient capital, and access to industrial testing facilities.
Government procurement can create opportunities for innovative domestic firms when transparent standards, competition, and performance requirements are maintained.
Entrepreneurs should receive guidance on intellectual property, product certification, market research, cybersecurity, and regulatory compliance. Support must extend beyond the initial startup stage to help successful innovations achieve commercial scale.

9.4 Build a Skilled and Research-Oriented Workforce

India's demographic potential can become an economic advantage only when people possess relevant knowledge and skills.
School and higher education curricula should be updated regularly to include scientific reasoning, digital literacy, data analysis, computational thinking, and emerging technological fields.
Technical institutions should collaborate with employers to provide internships, apprenticeships, practical training, and industry-relevant qualifications.
Researchers also require training in research ethics, statistics, reproducibility, scientific communication, entrepreneurship, and intellectual-property management.
Lifelong learning programmes will be necessary as automation and AI reshape occupational requirements.

9.5 Encourage Regional Innovation Ecosystems

Innovation should not remain concentrated in a few metropolitan centres.

Each state should identify its strengths and develop specialized research and innovation clusters. For example, regions with strong agricultural institutions can focus on agricultural technology, while industrial regions can prioritize manufacturing, materials, and automation.

State universities, technical colleges, local industries, public laboratories, and entrepreneurs should work together to solve regional problems.

District-level innovation programmes can encourage students and small businesses to develop solutions for local transport, sanitation, water management, healthcare, and agricultural challenges.

10. A Phased Roadmap from 2026 to 2047

A long-term vision requires measurable intermediate objectives and periodic evaluation. The following roadmap presents a proposed framework rather than a statement of officially adopted government targets.

Phase I: Foundation and capacity building, 2026–2030

The immediate priority should be to strengthen research infrastructure, increase funding predictability, improve university laboratories, and expand access to advanced computing and scientific equipment. Government, industry, and academic institutions should establish shared research facilities and develop mechanisms for faster technology transfer.

AI skills, semiconductor design, biotechnology, renewable energy, and advanced manufacturing should receive appropriate attention. Regional innovation programmes should be expanded to include smaller cities and state universities.

Phase II: Expansion and commercialization, 2031–2040

The second phase should focus on scaling successful research programmes, developing competitive domestic technology companies, and strengthening manufacturing capabilities.

India should aim to increase domestic value addition in strategically important industries and improve the commercialization of research. More universities should participate in international research networks, while startups should gain better access to testing, certification, finance, and global markets.

Technological innovation should also be integrated into public healthcare, education, agriculture, environmental management, and urban infrastructure.

Phase III: Global leadership and inclusive development, 2041–2047

The final phase should consolidate India's position as a major producer of scientific knowledge and advanced technologies.

India should aim to demonstrate internationally competitive research capabilities, globally successful technology firms, strong domestic innovation networks, and widespread access to technological benefits.

By 2047, scientific and technological progress should be reflected in higher productivity, better employment opportunities, improved public services, lower environmental damage, and stronger resilience to global disruptions.

Progress should be assessed through transparent indicators such as research expenditure, research quality, private-sector investment, technology exports, domestic value addition, startup survival, workforce skills, regional inclusion, and measurable social and environmental outcomes.

11. The Role of Citizens, Educational Institutions and Industry

Achieving Viksit Bharat requires participation from the entire society. Students should develop scientific curiosity, question assumptions, and participate in research projects, innovation competitions, and practical experimentation. Teachers should encourage inquiry-based learning and help learners connect scientific concepts with real-world problems.

Universities must promote research integrity, interdisciplinary collaboration, and entrepreneurship. They should encourage students to identify problems in their communities and develop evidence-based solutions.

Industries should invest in research, support workforce training, collaborate with universities, and provide pathways for promising technologies to reach the market.

Governments should establish clear policies, maintain transparent funding mechanisms, support essential research, and ensure that technological benefits reach disadvantaged communities.

Citizens can contribute by adopting sustainable practices, participating in public consultations, supporting scientific literacy, and evaluating technological claims critically.

Women and underrepresented groups must have equal opportunities to become scientists, engineers, inventors, entrepreneurs, and technology leaders. A broad and diverse talent base will improve the quality and relevance of India's innovation system.

Ultimately, national progress will depend on creating a culture in which evidence, creativity, ethical responsibility, and continuous learning are valued across society.

12. Conclusion

Science, technology, and innovation will play a decisive role in India's journey towards Viksit Bharat @ 2047. They can improve productivity, generate employment, strengthen strategic autonomy, modernize public services, and address pressing challenges in agriculture, healthcare, education, energy, and environmental protection.

India has developed important strengths in information technology, pharmaceuticals, space science, digital infrastructure, and engineering. New opportunities in artificial intelligence, biotechnology, semiconductors, quantum technologies, robotics, and clean energy can help build on these achievements.

Nevertheless, technological ambition must be supported by sustained research investment, stronger universities, skilled human resources, effective industry–academia partnerships, responsible governance, and equitable access to innovation. India must also bridge the gap between scientific discovery and practical implementation.

The journey towards a developed nation cannot be measured solely by economic growth or technological sophistication. It must also be evaluated through improved living standards, accessible healthcare, quality education, productive employment, environmental sustainability, and equal opportunities for all citizens.

The vision of Viksit Bharat @ 2047 therefore calls for a transition from technology adoption to technology creation, from fragmented research to collaborative innovation, and from isolated scientific achievements to solutions that generate widespread public value.

If India successfully integrates scientific excellence with entrepreneurship, ethical responsibility, and inclusive development, it can emerge as a leading knowledge economy and a significant contributor to global scientific and technological progress. The realization of this vision will require long-term commitment from

government, industry, educational institutions, researchers, and citizens.

A developed India by 2047 will be built not merely through the consumption of advanced technologies, but through the ability to discover, invent, manufacture, and deploy technologies that improve human life. Science creates knowledge, technology enables application, and innovation converts both into progress. Together, they can provide the foundation for a prosperous, self-reliant, sustainable, and inclusive Viksit Bharat.

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