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India’s National Innovation System: Roadmap to 2020

Abstract

The paper describes the genesis of National innovation System, its basic components and India’s journey in innovation space, its overall position, government’s efforts and finally suggestions for taking some new steps to shift its orbit from a mere service provider to a nation with strong national Innovation System.

Introduction

Immediately after World War II, a linear model of science and technology ‘push’ was dominant in the science councils in majority of the developed and industrialized nations. This linear approach has remained prominent as a guiding principle among policy makers. However, it fails to explain differential rates of technological innovation and economic development experienced by industrialized countries. Traditionally, policies focused on inputs (R&D expenditures, human resources for example) and outputs (research papers and patents, for example). These are treated as conventional indicators which although give impression about contents of endeavors, convey very little about “innovativeness” of an economy.

The concept of ‘National Innovation System’ (Freeman, 1995) has started taking centre stage with increased attention in many developing countries, particularly India.

What is National Innovation System?

National Innovation System has been defined differently by various experts. For example, Freeman (1997) defines it as “the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.” Lundvall (1992) opines it as “the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and are either located within or rooted inside the borders of a nation state”. Whereas, Nelson (1993) simply sees it as “a set of institutions whose interactions determine the innovative performance ... of national firms. Palel and Pavitt explain it as “... the national institutions, their incentive structures and their competencies that determine the rate and direction of technological learning in a country”. The definition more inclusive appears to be that of Metcalfe (1995) which elaborates it as “That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As

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such it is a system of inter connected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies”.

Whatever the definition may be the very concept of National Innovation System encompasses various players, including people involved in production, distribution, and applications of various types of knowledge in the Innovation chain of a country.

The distinct role played by members of National Innovation System which comprises enterprises both from public and private sector, universities, publicly funded R&D organizations, and policy makers.

**Significance of National Innovation System**

The concept of National Innovation System signifies the increasing importance of the economic role of knowledge. It is evident that emerging economies, world-wide, relies on the strength of knowledge. Economic activities are becoming more and more knowledge-intensive as seen in the growth of high-tech industries and the increasing demand for highly skilled people. A sound National Innovation System of a country reflects the rise of ‘systemic approaches’ to the study of technology development. It stresses dynamic networks of policies, institutions and people that mediate knowledge flows across national borders and within the Country’s enterprises. It also projects a more realistic picture of development processes since it views innovation efforts as intimately linked to broader macroeconomic and educational policies. In context of NIS of developing countries (Juma et al 2001) correctly sees that “technology policy should be demystified. It does not need to be a business just for developed countries nor seen as a kind of unnecessary and wasteful luxury for poor countries”.

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**Box No. 1.**

**Innovation System in a Nutshell.**

  - Create new knowledge;
  - Guide the direction of the search process;
  - Supply resources i.e. capital and competence;
  - Facilitate the creation of positive external economies; and
  - Facilitate the formation of markets

- **Viotti (2001)**
  - Absorb knowledge actively;
  - Generate opportunities of learning; and
  - Develop technological capability

- **Liu and white (2001)**
  - Research (Basic, Developmental, and Engineering);
  - Implementation (Manufacturing);
  - End-use (Customers of the product or process outputs);
  - Linkage (Bringing together complimentary knowledge); and
  - Education
Although the overall function of NIS is to produce, diffuse and to use innovations, its functional constituents vary from researcher to researcher. Box No. 1 presents minds of few leading researchers of the field.

There are several players in the National Innovation System of a country. (Figure 1)

Figure 1: **Various players of National Innovation System**

**NIS in Indian Context**

In recent past there is marked change in global environment where the capacity to innovate and commercialize new high-tech products has taken the shape of a distributed global network. Sensing this pulse, India also recognizes the strategic and economic importance of competitiveness and taken several steps to strengthen its National Innovation System.

India has been recognized, as a rising economic power and increasingly important locus of advanced research and development as cited in the report ‘Rising Above the Gathering Storm.’\(^1\) Not only that, country has emerged also as one of the hotspots for providing conducive environment for offshore corporate R&D. More than 300 multinational companies have set up their R&D centres in India. India’s R&D institutions Centre for Scientific and Industrial Research (CSIR), Defence Research and Development Organization (DRDO), Indian Space Research Organisation (ISRO), Indian Council of Agriculture Research (ICAR) and others (Ref). from Government sector and Tata, Nicholas Piramal, Shanta Biotech etc in private sector, have surprised the world with their repetitive successes in their respective domains.

Historically speaking, India keeps on stunning the world as it has many path breaking innovations in its basket. It all started with the invention of zero and decimal system (way

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\(^1\) “Rising above the gathering storm and energizing and employing America for a brighter economic future” by The National Academic Press in 2007.
back in the 6th Century) and continued the journey through pioneering universities of Nalanda and Taxila, architectural and engineering marvels such as Iron pillar of Qutub Minar, Arthshastra, Rigveda, Upanishads, Indian knowledge systems in medicine, mathematics, astronomy, dance, music and so on.

In recent period, after Independence, India achieved some major innovative results such as “green revolution” - an agricultural independence - through which India is able not only to feed its populace but also in exporting its surplus stock. The next notable revolution is the “White revolution” which positioned India along with the top milk producing countries of the world. India joined the elite group of handful nations having capabilities in space science and technology, including design, and construction of launch vehicles. India’s indigenous technological capabilities range from prospecting of raw materials to the design and construction of large nuclear reactors.

**Present Scenario**

There is no doubt that India had a glorious past with reference to many path breaking innovations. However, India is slipping in Global Innovation Index (GII) ranking. As per the study conducted by Confederation of Indian Industry (CII), and INSEAD Business School, Paris, India has dropped from 23rd position in 2007–08 to 41st in 2008-09 and to 56th in 2009–10, amongst 132 nations surveyed. GII has two components - Inputs and outputs. Inputs cover institutions and policies, human capacity, general information and communication technology, infrastructure, market and business sophistication. On the other hand output includes knowledge generation (patents and publications), competitiveness and wealth. The ranking is only relative which shows other countries are moving faster than India in terms of five pillars of innovation as mentioned above.

Thus, India needs to shift its orbit from a mere service provider to an innovative nation. As mentioned earlier, Government has a commanding role in formulating, executing, monitoring and exploiting the outcomes of its National Innovation System. Realizing the importance, our Government has recently taken several steps towards building up a strong National Innovation system.

New Millennium India Technology Leadership Initiative (NMITLI) of Council of Scientific and Industrial Research (CSIR), Technopreneur Promotion Programme (TePP) of Department of Scientific & Industrial Research (DSIR), and Innovation in Science Pursuit for Inspired Research (INSPIRE) of Department of Science & Technology, New Delhi, are some striking initiatives taken by the Government to strengthen its Innovation Ecosystem. National Innovation Foundation, headquartered at Ahmadabad, under direct control of Department of Science and Technology, is another active player of India’s Innovation System. In a truly innovative way it scouts and documents grassroots innovations and traditional health practices covering entire length and breadth of India. It has collaborations with major public funded R&D institutes like CSIR and Indian Council of Medical Research for validation/value addition to these grassroot innovations.

Furthermore India is emerging as new centre for technological revolutions as is being reflected by sequencing first human genome in India by CSIR-Institute of Genomics and Integrative Biology (IGIB). With this, India joined the elite group of countries undertaking advanced research in the area of genomics. A purely innovative measure has been taken by CSIR in
launching ‘Open Source Drug Discovery (OSDD)’, where more than 4500 researchers, across
the world came together through virtual network to solve the ever-increasing health problem
of India namely, Tuberculosis.

The importance given to boost National Innovation System could be judged by declaring
2010-20 as decade of Innovation’ by the Government of India. Government has also constituted
“National Innovation Council” (NInC). The terms of reference of this Council are three-
pronged:

(i) To formulate a roadmap for innovation for 2010-2020;

(ii) To promote setting up of State and Sector Innovation Councils to help implement strategies
    for innovation in states and specific sectors, and

(iii) To create a framework for –
    • Evolving an Indian model of innovation with focus on inclusive growth,
    • Developing and championing innovation attitudes and approaches,
    • Creating appropriate eco-systems and environment to foster inclusive innovation,
    • Encouraging central and State Government, universities, and R&D institutions to
      innovate,
    • Facilitating innovations by SMEs and many more.

NInC is in the process of creating a Gram Swaraj Portal that is expected to link 2.5 lakh
panchayats which will provide information support for employment, education, health,
upgrading skills of grassroot functionaries, real-time feedback on delivery of public services,
computer based literacy testing and e-library at panchayat levels.

Recently Government of India has launched National Innovation Portal which serves as a
single repository for information related to innovators and innovations for prospective
innovators and policy makers. It also serves as platform for idea exchange, for fostering
industry-academia partnerships, national and global collaborations.

Another significant initiative by Government is the formulation of National Innovation Act.
The responsibility of bringing this Act into force lies with the Department of Science and
Technology. The main objective of this Act is to facilitate public or private initiatives and
public-private partnerships to build an innovation support system; develop a national
integrated science and technology plan; and codify and consolidate the law of confidentiality
to protect confidential information, trade secrets and innovation. The proposed Act focuses
on increasing investment in R&D and enacting data confidentiality clauses to make India a
preferred destination for research-oriented industries such as IT, Pharma and Engineering.

Further, Government is in the process of creating  Bharat Nirman Innovation Fund at a size
of Rs.50 billion which primarily targets to support innovations for providing solutions for the
bottom of the development pyramid and secondly to  support five to six national challenges
requiring innovations.

**Way Forward:** As mentioned earlier, to have an effective National Innovation System,
every player in this gamut, viz. government (both Central and State), R&D institutions (both
publicly funded & Private), academia (IITs, IIMs, Universities, NITs and even private
Engineering Colleges), industries (both public & private sectors), financial institutions (venture
capitalists, Angle funding etc), individual innovators has to play a very focused and distinctive role. There must be a very strong networking amongst above-mentioned agencies. It is suggested that monitoring can be done by National Innovation Council.

Following steps are suggested to be taken vigorously in order to achieve global leadership by implementing effective NIS.

**R&D capability: India's share in terms of Patent, Publication GERD**

Figure 2 shows how India is placed globally in terms of research publications and patent filing in the USPTO during 2008.

**Global Data for Scientific Publications**

![Image of Global Data for Scientific Publications]

**USPTO Trend for Patent Filing**

![Image of USPTO Trend for Patent Filing]

Figure. 2:

Increasing GERD can provide our researchers a world-class environment which may be able to place India as leader in some of the research domains such as biotechnology, genomics, space, materials, agriculture, ICT engineering, pharma, etc. Fig.3 provides a glimpse of how GERD in India has progressed over the years.
Human Capital
The stock of qualified human resource in India has to be increased many fold. The country has at present a strength of 90 million in the age group of 17–21 years. It is necessary to channelize this huge potential in meaningful manner. Government has to tap this energy lying (mostly untapped) in the vast network on state universities. Another gold mine is the ensemble of engineering colleges.

Government is targeting to double the existing 15% Gross Enrolment Ratio (GER) to 30% by 2020\(^{17}\). That translates into increasing enrolments in the tertiary sector three times from around 13 million to 40 million. However, it needs massive capacity building, both intuitional and human.

Infrastructure
Providing good infrastructure is one of the most significant pillars of National Innovation System. It should offer a pleasant and conducive environment. If one wants to start new high-tech enterprise, all the attendant facilities, like bank, consultant services (to solve taxation puzzles) should be provided to them.

Fund
Creation of National Innovation Fund is another essential component of NIS. Although thinking about this is going on for a couple of years, it must be operationalized without delay.

Science, Technology and Innovation
It is necessary to inculcate the concept of S, T and I in Society by and large and in schools and colleges, spread across the country in particular. Here State Innovation Councils can play a vital role, however, co-ordination with NInC is called for. Non-Government Organizations can also be pitched in for the purpose.
S&T Policy and Vision

The most recent S&T policy on India was formulated in 2003. Although several points of this Policy are relevant still, country needs a fresh thinking, and this time it has to fructify as Science, Technology and Innovation Policy. Under guidance of National Innovation Council with the involvement of all the S&T departments. A new vision for the country has already been formulated to address the pressing problems\textsuperscript{18} such as ‘Equity and social justice’, ‘Universal access to Education’, ‘Energy Independence’, ‘Health-care for all’, ‘Efficient water management’, ‘Food security’, ‘Mitigating effects of possible change’, ‘Strengthening the innovation ecosystem’, ‘Skill development for better employment opportunities’, and ‘National Security (both internal and external) through S&T intervention’. Efforts are needed to bring all the concerned agencies together to provide solutions, both in short-term and long-term perspective.

Coordination between Academia and R&D institution

It is essential to have better co-ordination between academic and R&D institutions. On the one hand majority of the academic institutions in the country lack good infrastructure, equipment and other associated facilities for carrying out world-class research, and on the other, publicly funded R&D institutes have excellent facilities but suffer from dearth of young workforce. A mechanism has to be defined for a better coordination between these two forces. It must be beyond simple funding to the projects of the universities.

ST&I Parks

On the pattern of IT-Parks, developed at many places, STI Parks need to be developed across the country. It will help in setting up new and innovative facilities from basic to applied research, technology incubation, up-scaling, etc., by involving academic institutions, R&D institutions, and industries.

Conclusion

India was known for its innovation pursuits. India still has many strengths, like young population, institutions of growing economy, and large R&D infrastructure.

There is no second thought that India needs a very effective National Innovation System. Some efforts are being pursued by Government agencies and corporate houses, in this clirestron however, more concerted efforts are needed.

We have to look far beyond the scientific outputs (papers and patents) resulting from scientific R&D laboratories. There is a strong need to streamline and strengthen a comprehensive environment encompassing industry, academic institutions, legal and financial sectors and, of course, scientific R&D institutions to spearhead the growth. Countries those are able to make breakthrough in new global challenges such as mitigation of climate change, energy security, and sustainable agriculture will become super power in the continuously changing global dynamics. India has all the potential to implement an effective National Innovation System in order to generate and take solutions to the bottom of development pyramid.
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References


