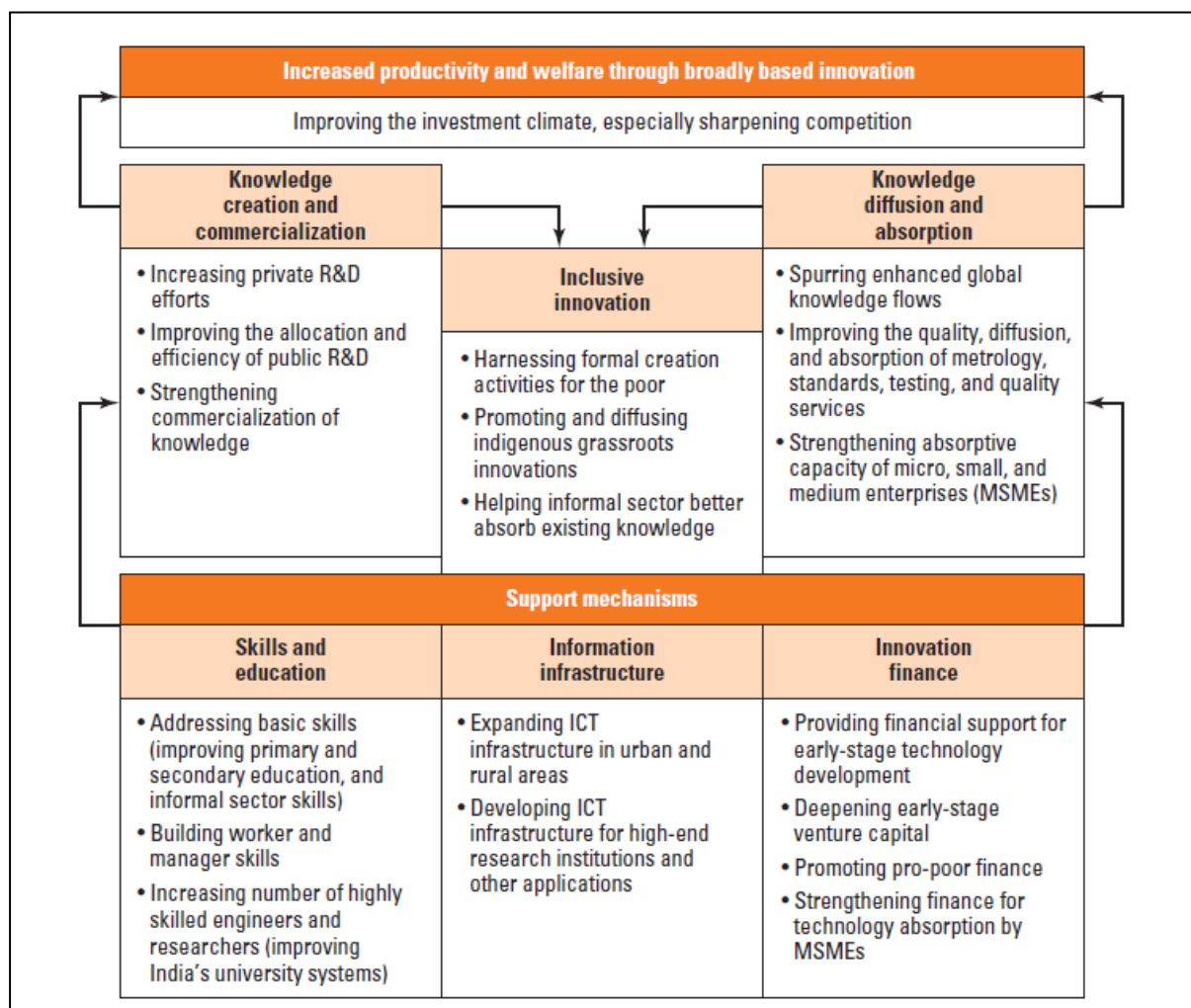


## CHAPTER 7                      BUILDING A CONCEPTUAL FRAMEWORK FOR NATIONAL INNOVATION POLICY

India faces an innovation challenge. Clusters can be powerful catalysts in this process and hence the research studies related to the innovative clusters merit due attention and appreciation. The Global Innovation Index reports conclude that India needs to improve the innovation performance to enhance its global economic competitiveness and bridge the innovation gap when compared to the innovating developed economies. The research efforts related to the *innovation ecology, the structure of innovative interactions, industrial interdependencies and the Government policies can help us plan and develop the cluster based policies to supplement the National Innovation Policy.*

**Figure 7.1      Innovation ecosystem**



Source: Mark A.Dutz

Efforts are afoot all over the world to plan, develop and implement a wide range of Cluster initiatives. European countries and regions have launched a wide range of cluster initiatives. Some of them have started clusters policies long ago (Catalonia and the Basque Country in Spain, Veneto in Italy ,Scotland in the UK, Sophia Antipolis in France, Denmark, the Netherlands) while others have started within the last few years (a number of Austrian regions, the Czech Republic ,the UK,Sweden)or have further developed them through national initiatives (France, Germany). Cross-border cluster initiatives operate in, for example, Republic of Ireland/Northern Ireland and the Oresund region. Activities specifically related to clusters are currently underway in several parts of the European Commission. The Competitiveness Innovation Programme, the Cohesion Policy, and the 7th Framework Programme include a wide range of activities open t o clusters, innovation and competitiveness.

Over the last few years, research efforts focused on *National Innovation Systems*, cluster analysis and cluster-based policy have gained global attention. Countries are increasingly using a “cluster approach” to analyzing *knowledge flows in national innovation systems* in recognition of the close interaction between certain types of firms and industries. These interactions may evolve around key technologies, shared knowledge or skills or producer supplier relationships. "Nations, whatever their overall level of innovative performance, do not usually succeed across the whole range of industries, but “in clusters of industries connected through vertical and horizontal relationships” (Porter, 1990). As the studies by DeBresson shows "the clusters display at an inter industrial level, underlying networks of interrelated cooperating businesses. The clusters are.... interdependent set of businesses structured through network relationships.

The use of innovation interaction matrices describing the flows of innovations from suppliers to users is promising, but is limited to the flows of major innovations of using and supplying industries. The main advantage of these tables is their focus on innovation interdependency and interaction between industry groups when innovating. Cluster based policy can play significant role in India’s economic growth and development .The cluster based policies can help

- Stimulating interactions and knowledge exchange between the various actors in systems of innovation;

- Identifying the policies that hinders the process of clustering and innovation;
- Planning for the cluster initiatives and the cluster improvement policy;
- strengthening the economic dynamism of existing clusters and to improving the opportunities for new clusters to emerge;
- helping Indian economy to build unique profiles of specialized capabilities to strengthen its relative competitiveness in the global economy;
- Policy formulation that allows competitive clusters to grow and structural change to occur;
- Encourage productive collaboration between companies, government agencies, research and educational institutions, and others that influence the overall ecology for innovative clusters;
- stronger cooperation between clusters with complementary strengths and between cluster initiatives learning from each other;
- Defining cluster-specific action agendas and strategies;
- strengthening the cooperation between cluster initiatives to create strategic business linkages and services platforms that leverage complementary assets and capabilities of different clusters;

Based on the research, the recommendations for India's Innovation policy should have the following considerations.

- The Research & Development expenses as the percentage of GDP should increase. In one of the articles 'What will it take for a resident Indian to win a Nobel Prize?' Dr R.A.Mashelkar said;
 

*'Indians can always argue that we do not win Nobel prizes because our investment levels are low. The US spends \$ 2.50 billion (Rs 1,125,000 crore) on R&D as against India's \$ 0.5 billion (Rs 22,500 crore). Size of the funding is, of course, important. You build large critical mass in a given field, setting up a competition. You empower the scientists hugely with modern tools so that they can run faster and arrive at the results first.'*

**Table 7.1: R&D Forecast**

| Region           | 2010<br>GERD<br>PPP<br>(Billion<br>U.S.) | 2010<br>R&D as<br>Percent<br>of GDP | 2011<br>GERD<br>PPP<br>(Billion<br>U.S.) | 2011<br>R&D as<br>Percent<br>of GDP | 2012<br>GERD<br>PPP<br>(Billion<br>U.S.) | 2012<br>R&D as<br>Percent<br>of GDP |
|------------------|--|-------------------------------------|--|-------------------------------------|--|-------------------------------------|
| Americas         | 473.7                                    | 2.3                                 | 491.8                                    | 2.3                                 | 505.6                                    | 2.3                                 |
| <i>U.S.</i>      | 415.1                                    | 2.8                                 | 427.2                                    | 2.8                                 | 436.0                                    | 2.8                                 |
| Asia             | 429.9                                    | 1.8                                 | 473.5                                    | 1.9                                 | 514.4                                    | 1.9                                 |
| <i>Japan</i>     | 148.3                                    | 3.4                                 | 152.1                                    | 3.4                                 | 157.6                                    | 3.4                                 |
| <i>China</i>     | 149.3                                    | 1.5                                 | 174.9                                    | 1.6                                 | 198.9                                    | 1.6                                 |
| <i>India</i>     | 32.5                                     | 0.8                                 | 38.0                                     | 0.8                                 | 41.3                                     | 0.8                                 |
| Europe           | 310.5                                    | 1.9                                 | 326.7                                    | 1.9                                 | 338.1                                    | 2.0                                 |
| Rest<br>of World | 37.8                                     | 1.0                                 | 41.4                                     | 1.1                                 | 44.5                                     | 1.1                                 |
| <b>Total</b>     | <b>1,251.9</b>                           | <b>2.0</b>                          | <b>1,333.4</b>                           | <b>2.0</b>                          | <b>1402.6</b>                            | <b>2.0</b>                          |

SOURCE: Battelle and R&D Magazine, 2012 Global R&D Funding Forecast, December 2011.  
NOTE: GERD: Gross Expenditures on R&D, PPP, Purchasing Power Parity. The Chinese government reports somewhat different estimates of 1.83% for 2011 and 1.76% for 2010. See “Statistical Bulletin on National Science and Technology Expenditures in 2010 and in 2011.

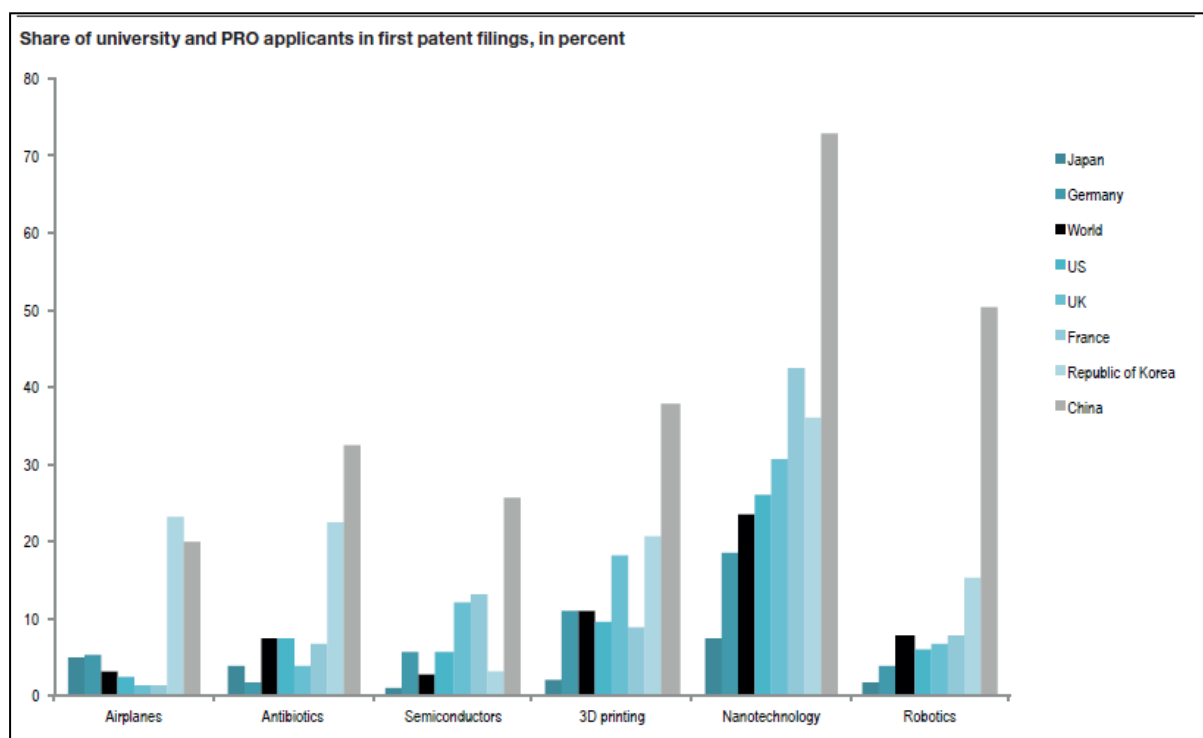
- Science, Technology and Innovation Policy must promote the culture of innovations and Innovation of culture. Indian Scientists in the past have contributed many “first to the world ideas”. The top 10 achievements of Indian STI in the 20<sup>th</sup> century as listed by Jayant Narlikar, one of the celebrated leading Scientists of India include the following:
  - a) *The contributions of Srinivasa Ramanujam;*
  - b) *Meghnad Saha’s ionization equation (1920) opening the door to stellar astrophysics;*
  - c) *S. N. Bose’s work on particle statistics (1922 );*
  - d) *C. V. Raman’s discovery that molecules scatter light (1928), the Raman Effect;*
  - e) *N. Ramachandran’s pioneering work in structural molecular biology ( mid-1960s), the Ramachandran Map& collagen triple helix;*
  - f) *The development of nuclear power and capability (1950s).*
  - g) *The Green Revolution in agriculture (the 1960s and 1970s).*

- h) *The Indian space programme and satellite fabrication with satellite vehicle launching capability (from late 1970s).*
- i) *The work in high temperature superconductivity (since the late 1980s).*
- j) *The transformation of the chain of 40 laboratories of CSIR towards an industry-oriented, performance- driven and accountable organization (in late 1990s).*

The PARAM Series of super computer was made by Dr Vijay Bhatkar, the most prominent IT scientist of India when USA had denied access to supercomputing. Thus the innovation potential of India cannot be questioned but we need to take measures to build the culture conducive to innovation.

- The policy efforts should further enhance the learning dynamics in the industries such as IT, Healthcare, Electricals & Electronics, Biotechnology and clean technology as the firms in these industries in India seem more active and dynamic. The focused strategy should be developed to enhance the cluster dynamics and cluster interactions.
- Institutional support mechanism to promote innovative linkages and interactions and the research & Development should be built by establishing well-funded public-private partnerships such as *Germany's Fraunhofer-Gesellschaft, Korea's Electronics and Telecommunications Research Institute, Taiwan's ITRI, and Finland's Tekes*. They have proven remarkably successful at helping domestic manufacturers translate new technologies into products and production processes. The support should also be extended in providing early stage finance.
- The university-industry interaction should be institutionalised to promote the applied research. WIPO report shows the rising share of University and PRO applicants in first patent filing in the emerging areas like aviation, 3D printing, Nanotechnology, Semiconductor, Robotics and antibiotics. Indian universities and the companies do not feature in the list.

**Figure 7.2: Share of University & PRO applicants in first patent filings**



**Table 7.2: Top10 patent applicants in 3D printing, Nanotechnology & Robotics since 1995**

| 3D Printing         |        |               | Nanotechnology     |        |               | Robotics  |        |               |
|---------------------|--------|---------------|--------------------|--------|---------------|-----------|--------|---------------|
| Applicant           | Origin | First Filings | Applicant          | Origin | First Filings | Applicant | Origin | First Filings |
| 3D Systems          | US     | 200           | Samsung Electr     | KR     | 2,578         | Toyota    | JP     | 4,189         |
| Stratasys           | US     | 164           | Nippon Steel       | JP     | 1,490         | Samsung   | KR     | 3,085         |
| Siemens             | DE     | 145           | IBM                | US     | 1,360         | Honda     | JP     | 2,231         |
| General Electric    | US     | 131           | Toshiba            | JP     | 1,298         | Nissan    | JP     | 1,910         |
| Mitsubishi          | JP     | 127           | Canon              | JP     | 1,162         | Bosch     | DE     | 1,710         |
| Hitachi             | JP     | 117           | Hitachi            | JP     | 1,100         | Denso     | JP     | 1,646         |
| MTU Aero Engines    | DE     | 104           | Univ of California | US     | 1,055         | Hitachi   | JP     | 1,546         |
| Toshiba             | JP     | 103           | Panasonic          | JP     | 1,047         | Panasonic | JP     | 1,315         |
| EOS                 | DE     | 102           | Hewlett Packard    | US     | 880           | Yaskawa   | JP     | 1,124         |
| United Technologies | US     | 101           | TDK                | JP     | 839           | Sony      | JP     | 1,057         |

Notes : JP-Japan, DE-Germany, KR-Korea, US-United States

The estimated market size of 3D printer seems very large, however no University has taken a lead in this direction of filing the patent .Thus our Innovation policy should encourage the research & development in these areas.

**Table 7.3: Estimated potential size/growth rate of 3D printer**

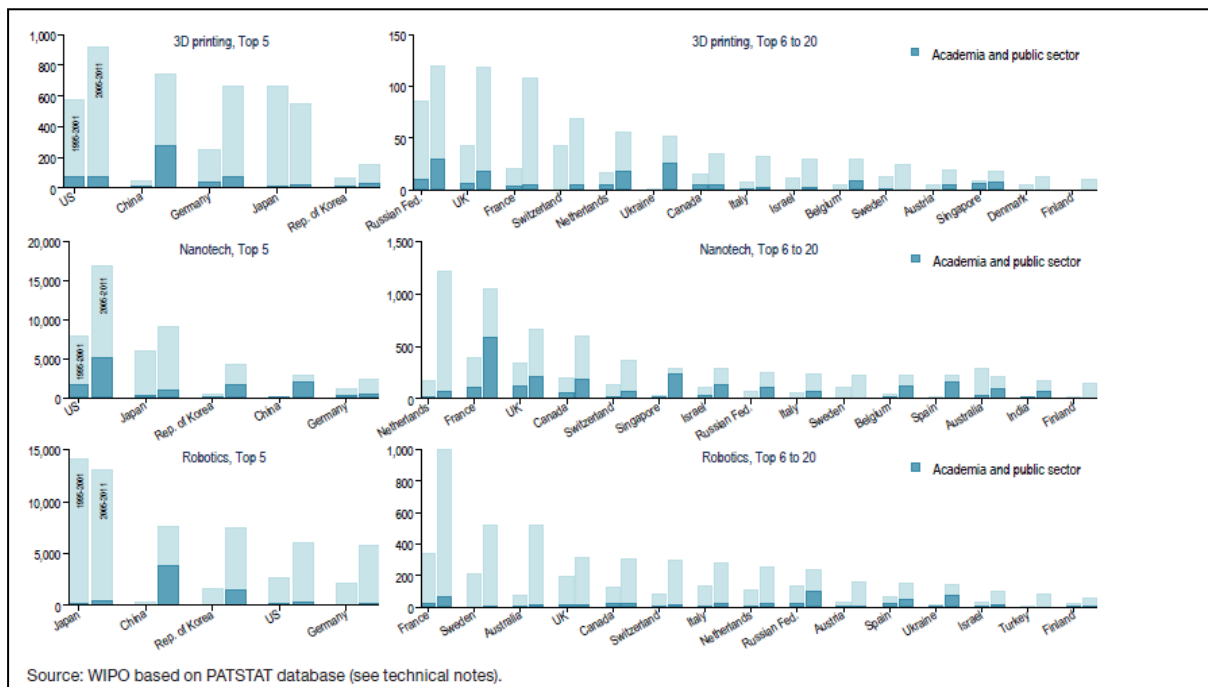
| <b>Market</b>   | <b>Estimated Potential Size/Growth Rate</b> | <b>Source</b>                |
|---|---|------------------------------|
| Global 3D Printing industry (associated technologies, products & services)  | USD 10.8 billion by 2021                    | Wohlers Associates,2013      |
| Global 3D Printing industry (associated technologies, products & services)  | USD 4 billion by 2025                       | Research & Markets,2013      |
| 3D printing materials market (including plastics ,metals, ceramics, others) | CARG 19.9% until 2018                       | RnR Market Research,2014     |
| 3D printing for medical application   | USD 965.5 million by 2019,CARG 15.4%        | Transparency Market Research |
| Source:Bechtold et al (2015)  |   |                              |

**Table 7.4: University & number of first patent filings**

| <b>University Name</b>                      | <b>Country</b> | <b>Number of first patent Filings</b> |
|---|----------------|---------------------------------------|
| Fraunhofer Society                          | Germany        | 89                                    |
| Chinese Academy of Sciences                 | China          | 79                                    |
| Huazhong University of Science & Technology | China          | 46                                    |
| MIT   | US             | 37                                    |
| Xi'an Jiaotong University                   | China          | 34                                    |
| University of Southern California           | US             | 31                                    |
| South China University of Technology        | China          | 27                                    |
| Harbin Institute of Technology              | China          | 24                                    |
| TNO   | Netherlands    | 24                                    |
| Beijing University of Technology            | China          | 17                                    |
| <b>Source: WIPO based on PATSTAT</b>        |                |                                       |

The absorption capacity building exercises should be encouraged through reverse engineering & knowledge sharing networks in India and overseas.

**Figure 7.3: Countries driving patenting in 3Dprinting, Nanotechnology & Robotics**



- Countries such as China and South Korea employ a powerful combination of state subsidies, national standards, preferential government procurement for national firms, and requirements for technology transfer to drive the growth of nationally based innovation. They also encourage state-owned or –supported enterprises to compete globally in strategic emerging industries with the help of low-cost loans—often with little concern for near-term return on investment or overcapacity.
- India should invest heavily in Broadband networks and other infrastructure required promoting learning, the knowledge flows and innovation. Once the innovative linkages are identified, cluster can be made more dynamic, productive and efficient.
- Efforts should be made to strengthen the link between manufacturing and innovation. Our finding show the lack of innovative clustering in manufacturing.
- Maharashtra, Karnataka, Tamilnadu, Andhra Pradesh, Delhi including NCR seem to be contributing significantly in terms of innovating activities. Kerala & West Bengal are also catching up but other states really lag behind